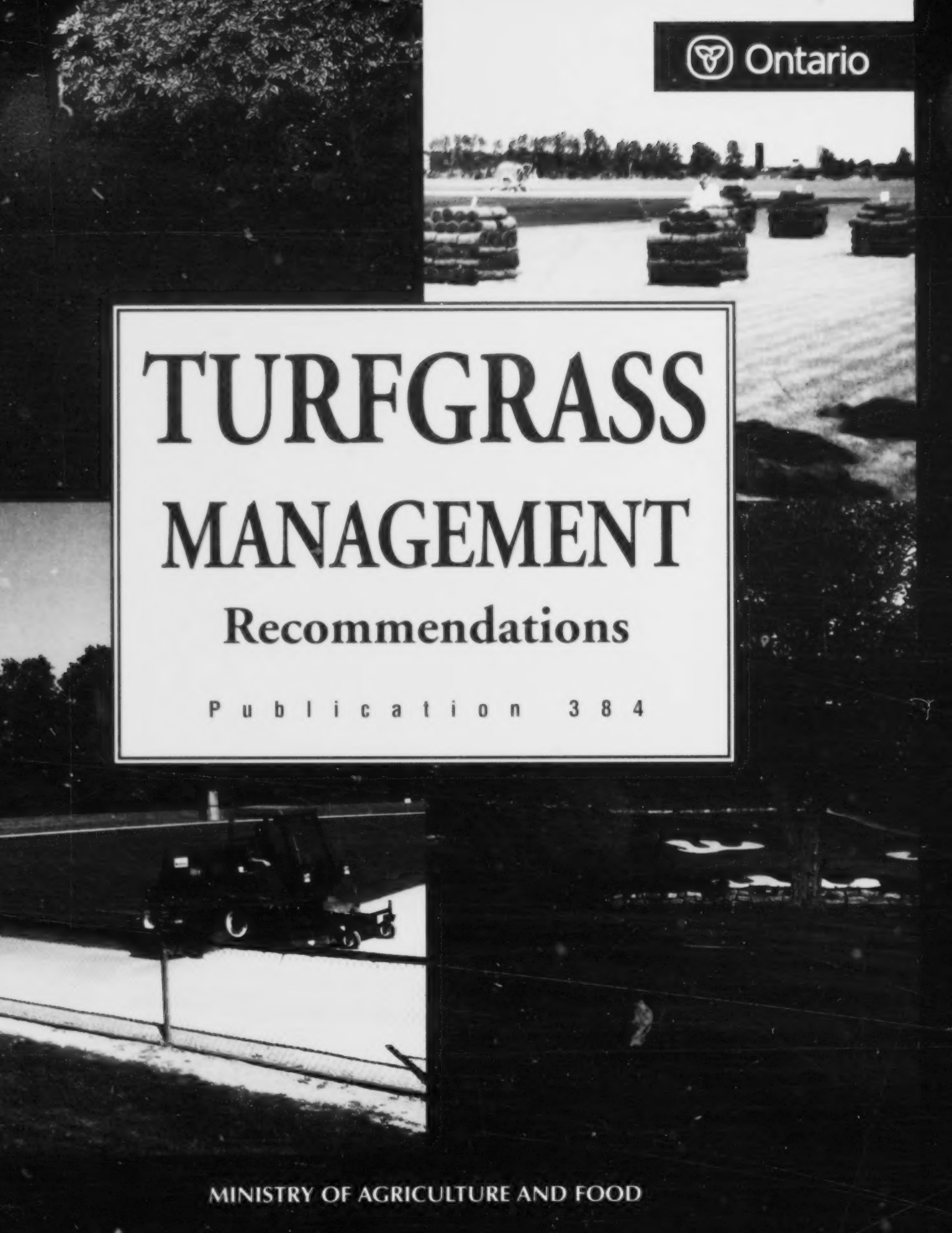

Ontario

TURFGRASS MANAGEMENT

Recommendations

Publication 384

MINISTRY OF AGRICULTURE AND FOOD

Recycle old editions of this publication. Each year the appropriate working group of the Ontario Pest Management Research and Services Committee reviews the pesticides listed in this publication. To the best knowledge of the committee, at the time of printing, all of these pesticides were:

- federally registered
- reviewed by the Ontario Pesticides Advisory Committee (OPAC)
- classified by the Ministry of the Environment as of November 2004.

The information in this publication is general information only. By printing this publication, the Ministry of Agriculture and Food does not offer any warranty or guarantee, nor does it assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

The pesticide product label is a legal document. It is against the law to use the product in any other way. You must also use all pesticides in accordance with the Pesticides Act and Regulation 914, administered by the Ontario Ministry of the Environment.

This publication lists a number of brand names of pesticides. This is for your convenience only. It is neither an endorsement of the product nor a suggestion that similar products are ineffective.

Consult each product label for specific information such as how to use the product safely, hazards, restrictions on use, compatibility with other products, and the effect of environmental conditions. Weather and other factors can influence the effectiveness of pesticides and the likelihood of crop injury, compatibility with other materials and the effect of environmental conditions.

Federal Registration of Pesticide Products

The Pest Management Regulatory Agency (PMRA) of Health Canada grants registration of pesticide products for use in Canada based on evaluation of scientific data to ensure that the product has merit and value, and the human health and environmental risks associated with its proposed use are acceptable.

1. **Full Registration**
   Pesticide registrations are normally granted for a period of five years, subject to renewal.
2. **Temporary Registration**
   Temporary registration may be granted for a period not to exceed one year, where the registrant agrees to produce additional scientific or technical information, or the pesticide is used for emergency control of a serious pest outbreak.

Maximum Residue Limits

Health Canada has established maximum residue limits (MRLs) for pesticides. Processors or retailers may demand more restrictive limits. Growers should seek advice of their intended market as to which restrictions or limitations apply. Keep accurate and up-to-date records on pesticide use in each crop.

Supplemental Labels

You MUST obtain a supplemental label and follow all the label directions when PMRA approves new uses for a registered pesticide that do not appear on the current label.

Examples of when you must use a supplemental label include:

- **Temporary Registrations for Emergency Use**
- **Minor Use Label Expansion** (new label statements for crops that do not already appear on that product label)

You can obtain a copy of a supplemental label from the pesticide manufacturer or pesticide vendor, the grower association that sponsored the emergency registration or minor use, from OMAF or PMRA's Pest Management Information Service.

For more information on the federal registration status check the PMRA web site at *www.hc-sc.gc.ca/pmra-arla* or call 1-800-267-6315.

Regulation of Pesticides in Ontario

The Ministry of the Environment is responsible for regulating pesticide sale, use, transportation, storage and disposal in Ontario. Ontario regulates pesticides by placing appropriate education, licensing and/or permit requirements on their use, under the Pesticides Act and Regulation 914.

All pesticides must be used in accordance with requirements under the Pesticides Act and Regulation 914. The act and regulation are available on the e-laws web site at *www.e-laws.gov.on.ca* or call Publications Ontario Toll-Free number: 1-800-668-9938 or 416-326-5300.

Classification of Pesticides into "Schedules"

The Ontario Pesticides Advisory Committee (OPAC) is responsible for reviewing and recommending to the Ministry of the Environment, the placement of pesticide products into one of six schedules used to control sale and use. Once approved by the Ministry of the Environment, classified products are posted on the OPAC web site: *www.opac.gov.on.ca*. For more information call OPAC at (416) 314-9230.

Licensing and Certification Requirements for Pesticide Users

You must be a certified grower or licensed exterminator to buy and use Schedule 1, 2 and 5 pesticides.

Requirements for Growers and their Assistants

For information about certification for growers and training for assistants refer to Chapter 1 of this publication or check the Ontario Pesticide Education Program web site at *www.ridgetownc.uoguelph.ca/opep/* or call 1-800-652-8573.

Requirements for Commercial Applicators and their Assistants

For information about exterminator certification and licensing and technician training refer to Chapter 1 of this publication or check the Ontario Pesticide Training and Certification web site at *www.ridgetownc.uoguelph.ca/optc* or call 1-888-620-9999.

Cette publication est aussi disponible en français.

105-06174/

Ontario

TURFGRASS MANAGEMENT

Recommendations

Publication 384

MINISTRY OF AGRICULTURE AND FOOD

Information in this book was contributed by:

- OMAF Crop Technology
- University of Guelph

Cover photo credits:

- Pamela Charbonneau, OMAF Turfgrass Specialist
- Erica Gunn, The Guelph Turfgrass Institute

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1. Pesticide Safety

When you decide to use a pesticide, choose the best formulations and application methods for the situation. To limit the negative impacts of pesticides:

- Select the least-toxic pesticide that will do the job.
- Use application methods that minimize pesticide drift or spread in the environment.
- Use only a properly calibrated sprayer. (See *Sprayer Calibration*, page 16.)
- Limit treatments to only the plants or sites where pests are a problem (i.e., use spot treatments).
- Take all possible precautions to prevent exposure of humans and non-target organisms to pesticides.

You must report all major spills, fires or thefts involving pesticides to the Ontario Ministry of the Environment at 1-800-268-6060. (Regulation 914, s.29)

Pesticide Schedules in Ontario

The Ontario Pesticide Advisory Committee is responsible for reviewing and recommending the placement of pesticide products into one of six schedules used to control the sale and use of the pesticides. See *Table 1-1. Pesticide Schedules.*

Table 1-1. Pesticide Schedules

Schedule	Who can use it	Pesticide characteristics
1	licensed exterminator certified grower only with approved permit	very toxic very persistent highly mobile
2	licensed exterminator certified grower trainee or technician under supervision (some restrictions apply) assistant agriculturist under supervision	toxic persistent moderately mobile
3	licensed exterminator certified grower trainee or technician consumer	moderately toxic moderately persistent slightly mobile
4	licensed exterminator certified grower trainee or technician consumer	low toxicity non-persistent non-mobile containers < 1 kg < 1 L
5	licensed exterminator certified grower assistant agriculturist under supervision	very toxic very persistent highly mobile less toxic or less persistent alternative not available
6	licensed exterminator certified grower trainee or technician consumer	low toxicity non-persistent non-mobile containers > 1 kg > l L

Certification and training requirements

You must be a certified grower or a licensed exterminator to buy and use Schedule 1, 2 or 5 pesticides. Assistants may also use these pesticides if they are trained and supervised as required.

Pesticide certification for Ontario farmers

Regulation 914 of the Pesticides Act requires that agriculturalists (growers) be certified to buy and use Schedule 1, 2 or 5 pesticides on land they farm. To become certified, agriculturalists must:

- attend the Grower Pesticide Safety Course (GPSC) and successfully complete the examination, and
- meet the definition of an "agriculturalist" as defined by Regulation 914 under the Pesticides Act (i.e., use farmland for agricultural or forestry production that falls within the farmlands property class under section 7 of the Ontario Assessments Act), and
- be at least 16 years of age.

Training for agricultural assistants using Schedule 2 or 5 pesticides

All assistants must have formal pesticide safety training, recognized by the Ministry of the Environment, before they can handle or use Schedule 2 or 5 pesticides under the supervision of a certified grower.

- This applies to all assistants, including family members, farm employees and seasonal workers.
- Trained assistants do not have to write an exam.
- Trained assistants must be 16 years of age or older.
- There are two training options for assistants. Assistants can:
  - attend a Grower Pesticide Safety Course and not write the certification examination, or
  - attend an on-farm training session presented by a qualified trained assistant instructor.
- For more information and a list of Grower Pesticide Safety Course session dates and locations, check the Ontario Pesticide Education Program website at www.ridgetownc.uoguelph.ca/opep/
- To register for a Grower Pesticide Safety Course anywhere in Ontario or for information about trained assistants:
  - call: 1-800-652-8573
  - fax: (519) 674-1589
  - e-mail: opep@ridgetownc.uoguelph.ca

Certification and licensing for commercial pesticide exterminators

If you plan to apply pesticides as a business, you must be a licensed exterminator.

This includes farmers who apply pesticides for other farmers for a fee. Licensed exterminators who are self-employed must hold an operator licence as well as the appropriate exterminator licence. Exterminator licences are valid for five years.

To become a licensed exterminator, you must:

- complete a home study course and certification exam through Ridgetown College, University of Guelph, and
- send proof of certification (letter of successful completion of the exam) and a fee to the Ministry of the Environment.

For updates to training requirements under Regulation 914 of the Pesticides Act, refer to the Ministry of Environment website at www.ene.gov.on.ca/ or phone 1-888-565-4923.

Training for technicians working as assistants to licensed exterminators

Assistants to licensed exterminators must become technicians to mix, load or apply all Schedule 3, 4 and 6 pesticides and most Schedule 2 pesticides (some restrictions apply), under the indirect supervision of a licensed exterminator. Technicians cannot mix, load or apply Schedule 1 or 5 pesticides. Technician cards are valid for two years.

To become a technician, you must:

- complete an MOE-approved academic course and exam, and
- complete practical training with a licensed exterminator.

For more information about certification and licensing requirements for licensed exterminators and training for technicians, contact Ontario Pesticide Training & Certification:

- tel: 1-888-620-9999
- fax: (519) 674-1585
- website: www.ridgetownc.uoguelph.co/optc

Extermination notification requirements for public and private land

Increasingly, the public is demanding to know where and when pesticides will be used, so they can take suitable precautions to avoid exposure. In particular the public wants to know about spraying in publicly accessible areas such as residential lawns, playing fields and parks where children, adults and pets may be exposed. Amendments to Regulation 914 under the Pesticides Act require posting a notice of pesticide use in Ontario on public land areas, and on residential land areas where pesticides are applied by licensed applicators.

For specific information refer to the Ontario Pesticides Act, Regulation 914 (www.e-laws.gov.on.ca/). Note that some municipalities have bylaws restricting pesticide uses, banning pesticide use or requiring specific notification measures.

Applicator's responsibility

The applicator must obtain suitable weatherproof signs in accordance with the regulation and complete them legibly. The applicator must ensure that signs are posted either 24 hours before application in the case of certain public lands, or at the time of application for private residential properties. The applicator must remove the signs on the third day after applying the pesticide from both categories of land. Contact your local Ministry of the Environment office for more information. Ministry staff are listed in Appendix H on page 70.

For more information on regulatory changes call toll free 1-888-620-9999 or visit the ministry website at www.ene.gov.on.ca.

Voluntary Integrated Pest Management accreditation

The IPM-PHC Council of Canada has developed a voluntary turf Integrated Pest Management (IPM) accreditation process. It is administered by University of Guelph, Ridgetown College. The IPM accreditation process will help reduce reliance on pesticides through the application of integrated pest management (IPM) and plant health care (PHC) principles, with particular emphasis on:

- cultural practices that promote optimum plant health
- pest prevention
- application of pesticides only when necessary
- use of reduced-risk products.

The IPM accreditation process accredits individuals and companies or organizations that demonstrate commitment to the principles of IPM. IPM is an approach that uses all available techniques in an organized process to suppress pest populations in effective, economical and environmentally safe ways.

Accreditation is achieved through a process of education, an examination, ongoing professional development, proven dedication to the principles of IPM and a commitment to a code of practice, and an audit. Voluntary IPM accreditation programs for turf are in place for lawn care and golf. A program for parks is under development through the Ontario Parks Association. More details can be obtained from the IPM/PHC Council of Canada at www.planthealthcare.ca, Ridgetown College at www.ontarioipm.com, the Ontario Golf Superintendents Association at www.golfsupers.com or the OPA website at www.opassoc.on.ca.

Municipal bylaws

Several municipalities have bylaws that restrict the use of pesticides for lawns, landscapes and golf courses. Many more are considering enacting such bylaws. As a turf manager, you need to be aware of any restrictions in your municipality or the municipality where you conduct business. Municipal pesticide bylaws can be found on each municipality's website.

General precautions

Always read the label first!

- **before you buy a pesticide**
- **before you begin to use a pesticide**
- **before you store it or dispose of it.**

Learn about the health hazards and toxic properties of the pesticide you are using. Consult the product label, Material Safety Data Sheet (MSDS) or manufacturer for this information. Check the company websites for MSDS information.

Protect yourself when you use pesticides

- Make sure someone knows where you are working, what pesticides you are handling and how long you expect the job to take.
- Post emergency numbers, including the poison information centre and spills action centre near all your phones.
- Keep a list of the names and the Pest Control Products (PCP) Act registration numbers of all the pesticides you handle. Keep a file of the pesticide label-booklets for all the products you use. Make sure your co-workers and family members know where this is in case of an accident.
- Have plenty of clean water, soap and paper towels — and an extra set of gloves and coveralls — nearby at all times in case pesticide contaminates your clothing or skin.
- Wear the correct protective clothing and equipment, and be sure that all items are clean and in good repair before you put them on.
- Never smoke, chew tobacco, eat or drink when you handle pesticides. Never carry tobacco or food in your clothes – and never leave tobacco, food or beverages in areas where you handle or store pesticides.
- Change your clothes and wash your hands and face before you eat, drink or smoke.
- Wash your hands before you use the toilet, as well as after. The skin in your groin area absorbs pesticides very easily.

If your clothes get wet with a pesticide — remove them immediately!

Protect other people, livestock, pets, water and sensitive crops

- Buy and store only what you need.
- Prevent drift.
- Keep pesticides out of water.
- Clean up spills quickly and safely.
- Dispose of containers and waste pesticide safely.

Protect bystanders

Take precautions to prevent exposure of bystanders to pesticides.

- Post notices in public areas stating where treatments are planned and have occurred. For specific information on applying pesticides to public lands, refer to the Ontario Pesticides Act, Regulation 914, at www.e-laws.gov.on.ca/.
- Apply pesticides during periods of lowest public activity, if possible (i.e., on weekends for school grounds, in the early morning for parks).
- Remove all objects from the area where you will apply pesticides.
- Avoid spraying areas near public roadways where children may be present.
- Advise owners or occupants on private land what precautions they may take to prevent exposure, such as staying off the sprayed area for 24 hours.

Prevent accidental release of pesticides

- Keep spray equipment (power hoses, backpacks, etc.) locked in vehicles or compartments of service trucks when not in use and during transport.
- Be prepared to handle pesticide spills and other emergencies. Have a pesticide spill kit and emergency phone numbers readily available.
- Never dispose of pesticides, empty containers or excess mixed pesticide on the property or leave them behind for the client to deal with.

Prevent property damage from pesticides

- Some pesticides can stain stucco and siding or cement sidewalks. Where there is a possibility that spray could land on such surfaces, check labels for precautions. If in doubt, test spray before applying the pesticide to the treatment area.

Take all precautions necessary to prevent drift off site. You might be liable for damages.

Human health

Risks of pesticide use

Each time you handle a pesticide, you are at some risk. The amount of risk depends on two things — the toxicity of that pesticide and your exposure to it.

Risk = toxicity X exposure

Toxicity

Toxicity is a measure of how harmful or poisonous the pesticide is. There are two types of toxicity: acute and chronic.

Acute toxicity

Acute toxicity is the toxic response that results from a single exposure to the pesticide. The symbols and words on the front panel of a pesticide label give you information about the acute toxicity.

Lethal dose 50% (LD_{50}) is a measure of acute toxicity. It is the dose (mg of product per kg of body weight) that will kill 50% of the test animals within a stated time (24 hours to 7 days). Those products with low LD_{50} ratings are highly toxic.

No registered products for turf have a high acute toxicity.

Chronic toxicity

Chronic toxicity is the toxic response that results from repeated exposures to small doses of a pesticide over a longer period of time. These toxic effects may not appear for months or years after exposure to the pesticide. The symbols on the label do not give information about the chronic toxicity of the product. Use protective clothing and equipment to help reduce exposure and the risk of chronic effects.

Cholinesterase blood tests

Organophosphate and *carbamate* pesticides can affect your nervous system. These pesticides can change your serum and red blood cell levels of an enzyme called acetyl cholinesterase. Your body uses this enzyme to transmit messages through your nervous system. If your cholinesterase levels fall, you can experience symptoms, including trembling, twitching, blurred vision, difficulty breathing and heart difficulties. Insecticides registered for use on turf that fall in the organophosphate and carbamate classes are carbaryl and diazinon. If you use either of these insecticides regularly, you should have regular cholinesterase blood tests. Your family doctor can arrange these tests, and OHIP covers them.

Have your first test before you begin to handle these pesticides. That will show the baseline (normal) cholinesterase level for your body. During the spray season, if you are spraying organophosphate or carbamate insecticides regularly for several weeks, you should have a cholinesterase blood test every 7–10 days. If your cholinesterase level drops to below one-half of your baseline level, you are showing signs of pesticide poisoning and you must remove yourself from exposure to these pesticides until your cholinesterase level returns to normal.

Exposure

Exposure is a measure of the contact you have with the pesticide. You can be exposed to the pesticide in three ways.

- Dermal exposure occurs through your skin or eyes. The amount and rate of pesticide that may be absorbed depends on several things, including:
  - your skin condition. If your skin is moist, or if you have rashes, broken skin or scratches, pesticide is absorbed more easily.
  - the part of your body that is exposed. Your eyes, genital area, scalp and ear canals absorb pesticides at a higher rate than your hands or arms. Your eyes absorb pesticides at a rate of 100%.
- Respiratory exposure (inhalation) occurs when you inhale small spray particles, dust, gases or vapours.
- Oral exposure occurs when a pesticide enters your mouth or you swallow a pesticide.

First aid

If an accident occurs:

1. Always protect yourself from injury first. Don't become another victim. Always put on protective clothing and equipment before you enter a contaminated area or handle a contaminated victim.

If symptoms occur during or shortly after handling a pesticide, go to a hospital. Take the pesticide label, MSDS sheet or pesticide container. Do not transport the container in the passenger compartment. Refer to the Emergency Procedures for Pesticide Poisoning on the inside back cover.

2. Check to see if the victim is breathing.
   If the victim is not breathing:
   - Straighten the victim's airway and check for breaths.

- If the victim does not begin to breathe, administer artificial respiration until the victim begins to breathe on his or her own.
- Do not contaminate yourself, especially if the victim has pesticide or vomit around the face or mouth. Use a face shield airway with a one-way valve. Do not breathe the exhaled air from the victim.
- Perform CPR if the victim's pulse disappears. You should only perform CPR if you are trained to do so.

If the victim is breathing, but unconscious:

- Place the victim in the recovery position (on the side with the head turned slightly to one side). If the victim vomits, try to keep the airway clear.

3. Stop the exposure to the pesticide. Move the victim away from the contaminated area. Remove all contaminated clothing. Use soap and water to wash any skin exposed to the pesticide.

4. Check the four basic facts:
   - What? Identify the pesticide. Look for the label, container or leftover pesticide.
   - How much? How much product was the victim exposed to?
   - Where? How did the pesticide enter the body? Did it enter through the mouth, skin, eyes or lungs?
   - When? How much time has passed since the victim was exposed to the pesticide, and how long was the exposure? Were the symptoms immediate or did the poisoning occur as a result of using the pesticide over a longer period of time?

Don't waste time.

If you can't answer these questions quickly, be ready to tell emergency personnel whatever you can.

5. Call an ambulance or the poison information centre.

6. Start the first aid treatment appropriate for the route of entry.

7. Make sure the patient gets medical attention. First aid is not a substitute for professional medical help.

Pesticide label information

Always read the label on the pesticide and follow the instructions.

Learn these symbols and words. They could save your life.

Four important symbols and words show the potential hazards of pesticides.

Hazard symbol				
Signal word	**Poison**	**Corrosive**	**Flammable**	**Explosive**

The hazard symbol always appears inside one of these shapes. These shapes and their warning words tell you the degree of hazard of the pesticide. The more sides to the shape, the more hazardous the product.

Warning symbol			
	Triangle = low hazard (3 sides)	**Diamond = moderate hazard** (4 sides)	**Octagon = high hazard** (8 sides)
Signal word	**Caution**	**Warning**	**Danger**

Check the label for special warnings about eye and skin hazards. The front panel of the pesticide label may also contain warnings that tell you the product is corrosive to eyes, or is a skin or eye irritant.

Protective clothing and equipment

Choose and wear the appropriate protective clothing and equipment.

Make sure your protective clothing and equipment:

- is what you need for the job
- fits properly, and
- is clean and in good repair and working condition.

The protective clothing and equipment you will need depends on:

- the pesticide you are using — Read the precautions section of the label to know what to wear.
- the job you are doing — For example, you need more protection when you handle concentrated pesticide or when you mix and load your sprayer.
- the type of application — For example, enclosed space or air blast sprayer applications made with open tractors require more equipment.

Each person who is working with pesticides needs his or her own set of protective clothing and equipment. Consult the technical expert at your safety supply company to make sure you buy the appropriate equipment and that it fits the user.

Clothing

For all pesticides, always wear:

- a water-repellent hat, such as a hard hat or waterproof rain hat. Do not wear hats, like a baseball cap, made from cloth. They absorb pesticides.
  - Sometimes you need to protect your entire head and neck, for example, if you apply pesticides in a greenhouse, apply dusty formulations or use an air-blast sprayer. In these situations, wear a hood or hat that protects your ear canals.
- long pants and a shirt with long sleeves or a coverall
  - Coveralls can be reusable or disposable. Reusable coveralls are normally cotton or polyester and should be tightly woven. Disposable coveralls should be designated for pesticide use.
  - Water-resistant coveralls are preferred because cotton, denim and cotton-polyester pants cling to the skin if they get wet, increasing the risk of dermal exposure.
- chemical-resistant gloves (unlined)
  - Use neoprene or nitrile gloves (PVC), unless the label states otherwise. Do not wear rubber gloves, as many pesticides can break down the rubber material. Wear your gloves under your sleeves with the top cuffed.
- chemical-resistant boots (unlined)
  - Wear your pant legs over your boots to prevent pesticide from running down inside your boots.

Read the label. It will describe what extra protective clothing and equipment to wear. For some pesticides you may also need to wear:

- goggles
  - Use safety goggles with indirect vents so that splashes do not enter your eye. Regular eye glasses don't provide complete protection. Never wear contact lenses when you handle pesticides.
- face shield
- chemical-resistant apron
- respirator
  - A respirator is a unit that covers your mouth and nose to prevent spray droplets, small particles and vapours from getting into your lungs. **A dust mask is not a substitute for a pesticide respirator.** Make sure you use cartridges and pre-filters that protect you against organic vapours. For more information about respirators, refer to the *Grower Pesticide Safety Course Manual*, Ridgetown College, University of Guelph.
  - You may need more protection, such as canister gas masks or a self-contained breathing apparatus (SCBA) when you apply:
    - any pesticide in an enclosed area
    - fumigants, gases, vapours or smokes.

When you work with fumigants, gases or vapours or when you apply any pesticide in an enclosed area, ALWAYS wear a respirator.

Use organic vapour tractor cab cartridges

If you use a tractor with a cab when you spray, use tractor cab cartridges, which work the same way as an air-purifying respirator. These cartridges and pre-filters must be replaced and

maintained regularly to provide continued protection.

When you use air blast sprayers and mist blowers and tractors without cabs, wear the appropriate:

- respirator
- waterproof suit
- head covering
- chemical-resistant gloves
- boots
- eye protection.

Once you complete the spray application, clean your protective equipment and the tractor. If you have not decontaminated the tractor, do not use it without wearing protective clothing and equipment.

Safety supply companies

Consult the safety supply companies of your choice for help in selecting your protective clothing and equipment. (See Table 1–2, *Safety Supply Companies in Ontario Providing Protective Clothing and Equipment*.)

Table 1-2. Safety supply companies in Ontario providing protective clothing and equipment

3-M Canada Inc.	Occupational Health and Environmental Safety Box 5757 London, ON N6A 4T1	(519) 452-6165 1-800-364-3577 Fax: (519) 452-4660
Acklands Grainger	90 W. Beaver Creek Rd. Richmond Hill, ON L4B 1E7	(905) 731-5516 1-800-668-8989 Fax: (905) 731-2798
Aearo Canada	7115 Tomken Rd. Mississauga, ON L5S 1X7	(905) 795-0700 1-800-387-4304 Fax: (905) 564-5250
Dutch Industries "Protect-Air Cab Filter"	Huron Tractor, Box 1300 Exeter, ON N0M 1S3	(519) 235-1115 Fax: (519) 255-1939
HAMISCO	3392 Wonderland Rd. London, ON N6L 1A8	(519) 652-9800 1-800-668-9800 Fax: (519) 652-9661
Kappler Canada	Box 1687 20 Ryan Place Brantford, ON N3T 5V7	(519) 752-4369 1-800-387-9326 Fax: (519)752-2161
Levitt-Safety (Eastern) Limited	2872 Bristol Circle Oakville, ON L6H 5T5	(905) 829-3299 1-800-668-6153 Fax: (905) 829-2919
MSA Canada Inc.	148 Norfinch Dr. North York, ON M3N 1X8	(416) 667-9400 1-800-267-0672 Fax: (416) 663-5908
Mitt & Robe Co.	751 Norfolk St. N. Simcoe, ON N3Y 3R6	(519) 428-4050 1-877-893-6565 Fax: (519) 428-5142
Plant Products Co. Ltd.	314 Orenda Rd. Brampton, ON L6T 1G1	(905) 793-7000 1-800-387-2449 Fax: (905) 793-9632
Safety Express	4060B Sladeview Cres. Unit 2 Mississauga, ON L5L 5Y5	(905) 608-0111 1-800-465-3898 Fax: (905) 608-0091
The St. George Company (Suppliers of Kasco Helmets)	P.O. Box 430 20 Consolidated Dr. Paris, ON N3L 3T5	(519) 442-2046 1-800-461-4299 Fax: (519) 442-7191

Care of protective clothing and equipment

After you complete the spray operation, clean all protective clothing and equipment.

Never let children, pets or livestock come in contact with contaminated clothing or equipment. Also make sure that they cannot come into contact with

the puddles of water left over from cleaning your equipment.

Wash your gloves with soap and water and leave them on to remove your other protective clothing and equipment.

With your hands still protected by gloves, wash protective equipment. It is best to wash equipment outdoors. If you do not have an outside clean-up area, keep certain buckets just for equipment clean-up. Mark them and keep them in a special place. Wash the inside and outside of your goggles, hat, boots and any water-repellent clothing in warm, soapy water, rinse well and let them air-dry.

Remove the cartridges and pre-filters from the respirator.

Discard cartridges, canisters and filter pads when breathing becomes difficult, or when you notice a pesticide taste or odour, or at the interval set by the manufacturer.

- Make a note of the date the cartridge is first used.
- Remove cartridges and filter pads from the face piece and store in clean, sealed plastic bags.
- Wash the face piece in warm soapy water, rinse thoroughly and dry in a well-ventilated area. Air-drying prevents damage to the inlet and outlet valves.
- Never use alcohol or other solvents for cleaning, as they will damage the rubber and plastic.

Place all dry articles in a clean storage area until next use.

Next, wash the outside of your boots and gloves with soapy water and remove them.

After removing boots and gloves, wash them inside and out with detergent and water, rinse thoroughly and dry in a well-ventilated area.

Always remove protective clothing and equipment outdoors. If you used a granular pesticide, shake the clothing outdoors in a safe place, emptying pockets and cuffs.

Throw out clothing that has been contaminated by spills of highly toxic or concentrated pesticide. Place clothing in a plastic bag and take it to a landfill site.

Coveralls and other spray clothing must be washed separately from other clothes. They should be washed after each use. Place them in a plastic bag and keep them separate until you wash them.

How to wash your spraying clothes

Never mix spray clothing with household laundry. Store and wash all clothing used for spraying separately from other clothing. Wash it after each use. Remember to use chemical-resistant gloves to handle pesticide-contaminated clothing.

- Presoak clothing before washing. Use one of three methods:
  - hose off garments outdoors
  - soak in separate tub or pail
  - use the prewash cycle in an automatic washer.
- Place the clothing directly into the washing machine. Wash only a few garments at a time. Do not wash with other family clothes.
- Use hot water, the highest water level and the longest cycle, with heavy-duty detergent. Wash as you would for heavily soiled clothing.
- Wash clothing again.
- After washing, hang outside (preferably in bright sunlight) until completely dry. Do not use the clothes dryer.
- Clean the washing machine. Run the washing machine through one complete cycle using only detergent and hot water (without clothing).

Personal hygiene

Always wash your hands before you eat, drink or smoke.

When you are finished for the day, take a bath or shower as soon as possible. The longer a pesticide remains on your skin, the greater the risk that it will be absorbed into your body.

Wash your hair and under your fingernails. Shower with lots of soap and water.

Always change into clean clothes.

Wear clean work clothes every day. A small spill on the previous day's clothes may seem unimportant, but wearing the same clothing again without washing it prolongs the exposure and increases your risk.

Protect the environment

Prevent contamination of adjacent land and water bodies

Do not allow pesticides to drift, run off or leach onto land or water bodies bordering treatment areas. Leave a suitable buffer zone between the treatment area and adjacent areas.

Buffer zones

Buffer zones are areas left untreated to protect an adjacent area, for example a pond, a stream, a sensitive crop, a non-target crop, wetland or woodland.

Protect adjacent land

No spray droplets should fall on adjacent properties, where treatments are not authorized. Areas of concern are:

- plants grown for human consumption
- plants sensitive to herbicide drift
- trees or shrubs that may be damaged by herbicides leaching to roots
- areas where children play.

Protect water sources

- Use an anti-backflow device to prevent back-siphoning when drawing water from wells, ponds, streams or other sources.
- Mix pesticide and load the sprayer away from any water supply, including wells, ponds or streams.
- Use buffer zones (untreated areas) when you apply pesticides to avoid contaminating surface water, wells, ponds or streams, especially those containing fish. Check the product label for specific buffer zone distances. See "Setback distances for water bodies" in next column.
- Do not allow equipment rinse water and excess pesticides to run into sewers or ditches with water in them. Rinse water should be put into spray tanks and applied to the treatment area. Otherwise, it must be disposed of as hazardous waste through a hazardous waste disposal company. For more information, see the section "Disposal of pesticides and empty pesticide containers" on page 12.
- Blow or sweep granular pesticides off driveways and hard surfaces, back into the turf, to prevent them from contaminating storm sewers.

Setback distances for water bodies

It is an offence under the federal Fisheries Act to introduce any material into water that may harm fish or fish habitat. To protect these waters, landscape applicators must determine a suitable setback distance between the area to be protected and the area where pesticide treatments are planned. The protected area includes the water body as well as adjacent riparian (riverbank) areas that contribute to fish food and habitat.

Preventing groundwater contamination

Groundwater is the source of water for wells and springs. If groundwater becomes contaminated with pesticides, it is difficult to clean. Preventing groundwater contamination is crucial. Some pesticides have the potential to leach through the soil to groundwater. Movement of pesticides into groundwater can make the water unfit for use.

However, pesticides applied to the soil are subjected to physical, chemical and biological processes that affect their movement through the soil and their potential for groundwater contamination. Pesticides applied to turf can be intercepted by the turfgrass plants themselves as well as by thatch. Making the right pesticide choices for the situation can help minimize the threat of groundwater contamination.

Soil characteristics

Soil texture plays a major role in pesticide performance and persistence. Soil organic matter can make a difference in pesticide activity. Therefore, it is important to select a pesticide based on soil type and organic-matter content. Chemicals tend to leach more readily in coarse-textured soils with low organic matter content. In contrast, fine-textured soils with high organic matter are

highly adsorptive and therefore have a low leaching potential.

Pesticide characteristics

Some pesticides bind strongly (adsorb) to soils and therefore are not easily removed. Clay materials and organic matter favour strong adsorption. Use soil analysis information on organic-matter content when selecting pesticides and application rates for your pest management program. Some pesticides are highly soluble in water, which can increase their leaching potential. Leaching of a pesticide can be minimized by pesticide dosage and by the timing and method of application. Choose the right pesticide for your situation.

The rate of degradation by natural processes is highly dependent on both the pesticide class (chemistry) and environmental factors. Sunlight, temperature, soil pH, microbial activity and other soil characteristics affect the breakdown of pesticide. Some pesticides break down slowly and therefore have a greater potential for leaching. On the other hand, short-lived pesticides may be degraded before any leaching occurs. Choosing a short-lived pesticide can minimize leaching potential.

Microbial degradation occurs when fungi, bacteria and other soil microorganisms use pesticides as a food (energy) source. High organic matter, along with other properties such as optimum moisture, aeration, temperature and soil pH, can enhance microbial degradation. In addition, chemical degradation of pesticides can occur by reaction with water, oxygen and other chemicals. In general, pesticides that are highly water-soluble, relatively persistent and not readily adsorbed by soil have the greatest potential for leaching.

Water table

High water tables may be vulnerable to contamination by pesticides and fertilizers due to the relatively short distance between the soil surface and groundwater. There is potential for groundwater contamination in areas with coarse-textured soils and high water tables. Specific application information for each pesticide is contained in the pesticide label. Careful adherence to application and disposal directions, combined with proper equipment calibration, provides the best method of preventing groundwater contamination.

Thatch layer

Thatch is composed of living and partially decayed leaves, roots, rhizomes and stolons. This layer of material accumulates between the layer of green vegetation and the soil. The thickness of this layer depends on the turfgrass species, environmental conditions and management practices. In a good growing environment, the rate of plant tissue accumulation often exceeds the rate of decay, resulting in the development of a moderate thatch layer. In general, a moderate thatch layer is beneficial for holding pesticides or nutrients. This prevents potential leaching through the thatch layer. Also, the organic matter in this layer increases as leaves, stems, roots and rhizomes decompose. This also helps with the binding of pesticides, thereby reducing potential leaching.

Prevent bee poisoning

It is important to protect bees when you spray. Honeybees, as well as other bees and insects, are important pollinators of crops. Some turf areas have flowering weeds such as clover that offer bees important sources of pollen.

If you choose to use insecticides for insect control, take these steps to prevent harming bees when you spray:

- Before you apply a pesticide, advise local beekeepers, so that they can move colonies out of the danger area. Contact the Provincial Apiarist at 1-888-466-2372 for a list of the beekeepers in your area.
- Do not spray turf areas with flowering weeds such as clover on which bees are foraging. If you must apply insecticides, spray after 7 p.m. when the bees are not foraging. If this is not a possibility, spray before 7 a.m. Bees usually do not forage at temperatures below 13°C.
- Do not apply insecticide on windy days to prevent drift toward any nearby hives.
- When there is a choice, choose the product formulation that is less hazardous to bees. Dusts are more toxic than sprays. WP formulations are more toxic than EC formulations.
- Under the Bees Act, it is an offence to spray in orchards while there is bloom on the trees.

Most organophosphate and carbamate insecticides are highly toxic to bees. These are examples of

insecticides used in crop production that are very toxic to bees:

Trade name	Common name
Diazinon	diazinon
Dursban	chlorpyrifos
Sevin	carbaryl
Success	spinosad

Read each pesticide label for specific precautions about bees.

Protecting non-target vegetation

Reduce and manage spray drift:

- Read the product label for information on buffer zones, water volumes and recommended nozzles.
- Use buffer zones around all watercourses and wells and neighbouring fields that contain sensitive crops. If the label does not state a specific buffer zone distance, leave an untreated area of natural vegetation. If not specified on the label, herbicides should be applied no closer than 1 m out from the drip line of trees. The drip line is the outer edge of the leaf canopy, where water drops from the foliage and where a tree normally has many roots.
- Select the recommended sprayer application rate (L/ha).
- Select the correct nozzle. Where practical, use air induction/venturi nozzles. These nozzles significantly reduce drift when compared to conventional nozzles.
- Select the correct nozzle-to-target distance.
- Spray only when winds are light to moderate (11 km/hr or less). If you notice drift is occurring because of the wind, stop spraying until the wind subsides. Do not apply pesticides if the wind is blowing towards susceptible crops or environmentally sensitive areas such as watercourses.
- Use spray plume protection where practical or available (hoods, shrouds, screens and air curtains).
- Use drift-reducing adjuvants in the spray tank as directed by the label.
- Use wick weeders instead of spraying when possible.
- Use non-volatile compounds.
- Avoid using non-selective residual herbicides in landscaped areas. Trees closer to the spray than twice their height can be severely damaged or killed.

Herbicide use precautions

Spray drift can damage or destroy susceptible crops a great distance from the sprayer. A high value crop that is particularly susceptible is grapes for wine. Although they are most sensitive during the early growing season, vines can be damaged any time there is exposed green tissue. If you are applying herbicides near a vineyard use extreme care.

- Use extreme caution when applying hormone-like herbicides (2, 4-D, MCPA, etc.) near susceptible plants or crops.
- Only apply these herbicides when it is calm (early morning or late evening) or when a very light wind is blowing away from any susceptible plants.
- Use only enough pressure to get uniform distribution (200-250 kPa). High pressures produce many small droplets that drift.
- Do not use the same sprayer for applying 2, 4-D and similar herbicides as you use to apply insecticides and fungicides.
- Drain and wash out the sprayer immediately after use.
- Do not empty herbicide mixtures or wash water into drainage ditches, streams or ponds or places where the herbicides can be washed into them.
- Do not mix different herbicides, or herbicides with other pesticides or foliar fertilizers, unless recommended by competent authorities.

For more information about spray drift, see the OMAF/Agriculture and Agri-Food Canada booklet *Best Management Practices — Pesticide Storage, Handling and Application* and the Ontario Pesticide Education Program (Ridgetown College) videos *How to Manage Spray Drift* and *Spray Drift Reduction Through Air Induction.*

Disposal of pesticides and empty pesticide containers

Triple or jet rinse empty containers

Unrinsed pesticide containers are not really empty. They may still hold about 1% of the original amount of pesticide. Although this figure

sounds low, it is still a hazard to humans, animals and the environment. To reduce the hazard, rinse each container three times as the spray tank is filling. Use the manual triple rinse technique or a specially designed device for rinsing containers. Paper or cardboard containers are often strong enough to be rinsed. If it is possible, rinse these containers as well as plastic ones.

Triple rinse
To triple rinse:

1. Fill the empty container at least 10% full of the diluting material (usually water).

2. Cap, then shake or roll the container so that the inside surfaces of the container are well rinsed.

3. Pour rinsings into the spray tank.

4. Repeat steps 1–3 twice more.

Remember to check the container after you have finished rinsing. Make sure that no pesticide has been left behind as a cake or paste on the bottom of the container.

Rinsing devices
Rinsing devices use pressurized water to clean out the container. They are just as effective as triple rinsing but take less time. Follow the manufacturer's instructions.

How to dispose of empty, triple-rinsed containers

Never re-use empty pesticide containers. They may be handy, but there is still some risk, even if the containers are triple rinsed. Never give empty, rinsed containers to anyone, especially children. Dispose of them promptly.

Regulation 914 of the Pesticides Act regulates how pesticide containers are to be disposed of in Ontario (Reg 914, s.27).

Metal, plastic or glass containers
Dispose of any empty metal, plastic or glass container that has been used to hold a Schedule 1, 2, 3*, 5 or 6* (*non-domestic) pesticide by:

- triple rinsing or jet rinsing using clean water or another appropriate solvent

and either

- taking it for recycling to a pesticide container depot

or

- taking it to a licensed waste disposal site.

Once containers are properly rinsed, puncture them to make it impossible to use them again and to make sure the rinse water is out of the container.

It is often more convenient to store empty, rinsed containers until you have collected enough to make a trip to the recycling pesticide container depot or the waste disposal site. If you store containers, keep them in a dry safe place, such as the storage area.

Recycling
The Ontario Pesticide Container Recycling Program is available to growers and commercial exterminators. Through this program, clean, triple-rinsed, plastic or metal pesticide containers (up to 23 L in size for plastic and 20 L in size for metal) can be returned to pesticide container depots located throughout the province. To locate the depot closest to you, call the Ontario Pesticide Education Program at 1-800-652-8573.

Paper and cardboard containers
Dispose of a paper or cardboard container that has been used to hold a Schedule 1, 2, 3*, 5 or 6* (*non-domestic) pesticide by:

- triple rinsing or jet rinsing (if possible) using clean water

and either

- burning (if municipal bylaws allow) in circumstances that persons and animals are kept out of any smoke and any smoke is directed away from buildings, highways, roads or outdoor areas frequented by the public

or

- taking it to a licensed waste disposal site.

Paper or cardboard containers are often rigid enough to withstand rinsing. If it is possible, triple rinse these containers as you fill the tank. Then

burn the containers in an isolated area on your farmland.

Be very careful around the smoke. It may contain toxic fumes from the burning pesticide. Be certain that there is no chance that a person or animal may breathe in this smoke. Make sure that the smoke does not drift toward buildings, roads or any public outdoor areas.

You can take these containers to a local waste disposal site for metal, plastic or glass containers. If you can't dispose of them immediately, keep them in a secure place such as the pesticide storage area.

Unwanted pesticides

If you have pesticides that you do not need or cannot use, be sure to dispose of them safely.

- Contact the supplier. It is sometimes possible to return unused pesticide if it is still in its original container.
- If you cannot find any way to use the product as shown on the label, then the Ministry of the Environment requires that waste be disposed of by licensed waste haulers to a licensed waste disposal site. Look in the Yellow Pages under "Liquid Waste Removal."
- Watch your local paper for "Municipal Hazardous Waste Collection Days" or contact your municipality. If your municipality has no waste collection days, encourage it to sponsor such an event. On these days, you can turn over surplus pesticide concentrates (maximum 25 L) for disposal.

Surplus spray mix

The best way to dispose of any excess spray mix is to find other fields that require an application of this pesticide. Before spraying, check the label to make sure the pesticide is registered for use on that crop.

If you can't find another field to spray, dilute the remaining spray mix by adding 10 parts of water for each 1 part of spray mix. This diluted solution can be safely applied to the treated area as long as you do not exceed the pesticide rate recommended on the label. Be sure to check the label for any restrictions about crop rotation, days to harvest or surplus spray mix disposal.

NEVER re-spray the treated field with undiluted spray mix. Spraying an area twice will double the recommended pesticide rate. This may cause illegal pesticide residues in the harvested crop or harmful residues in the soil that can cause crop damage.

Soluble packaging options

Choose soluble packages that dissolve in the spray tank to reduce container disposal. Water-soluble packaging is used for dry flowable and wettable powder formulations of pesticides and is available under names such as Clean Pak, Solupak and Toss-N-Go. In most cases, the water-soluble packaging material is PVA (poly vinyl alcohol). This material dissolves completely when added to the water in the sprayer tank according to instructions.

Read all labels and instructions carefully. For more details, contact your vendor.

Keep soluble pouches dry until you add them to the spray tank.

- Do not handle pouches with wet hands or wet gloves.
- Do not remove pouches from the outer package until you are ready to add them.
- Always reseal the outer package to protect the remaining pouches from moisture.

Mixing soluble pouches

- Consult product labels for specific mixing instructions for each product.
- Fill the spray tank half full of water. With the agitator running, add the water-soluble pouches to the tank.
- Most pouches dissolve completely within 5 minutes, depending on the water temperature and the degree of agitation.
- As the tank continues to fill, add any other compatible pesticides.

Do not add:

- a pesticide that is incompatible with the PVA packaging material. The PVA material is not soluble with summer-type oils (e.g., Superior Oil).
- any material containing boron (e.g., Solubor), chelated micronutrients or water-soluble fertilizers. This combination is likely to cause a sticky, insoluble substance in the tank. If you apply boron, chelated micronutrients or water-soluble fertilizers, make sure that you

completely empty and rinse the spray tank before you use any product packaged in PVA.

Storing pesticides

Ontario's Pesticides Act and Regulation 914 give storage requirements for storage facilities. The storage requirements that you must follow depend on which schedules of pesticides you store. See *Table 1-3. Pesticides Act storage requirements.*

Table 1-3. Pesticides Act storage requirements

	Schedule		
	3, 4, 6	*2*	*1, 5*
No contact with food or drink	✓	✓	✓
Does not impair health or safety	✓	✓	✓
Clean and orderly manner	✓	✓	✓
Warning signs posted on storage buildings	✓	✓	✓
Warning signs posted on unattended vehicles	✓	✓	✓
Emergency telephone numbers posted	✓	✓	✓
Ventilated to outside		✓	✓
Limited access (locked)		✓	✓
No floor drain		✓	✓
Safety equipment available		✓	✓
Area used exclusively for pesticides			✓

See also the OMAF Factsheet, *Pesticide Handling Facilities*, Order No. 94-037.

Always store pesticides in their original containers and keep them tightly closed. Never put pesticides in unmarked containers.

Pesticide spills

Protect yourself before you begin to clean up any spill. Clean up spills immediately.

In the case of minor spills:

- For liquids, cover the spill with a thick layer of absorbent material such as kitty litter, vermiculite or dry soil. Sweep or shovel the material into a waste drum.
- For powders and granulars, sweep or shovel the material into a waste drum.

In the case of a major spill:

- Remove any people or animals from the spill area.
- Stop the spill from spreading.
- Do not let the pesticide enter any watercourse.

If a pesticide spill causes, or is likely to cause, an adverse effect, you must notify the Ministry of Environment Spills Action Centre at 1-800-268-6060 (24 hours a day, 7 days a week) and the municipality.

For information on preventing spills, see the OMAF Factsheet, *Ways to Avoid Pesticide Spills*, Order No. 96-025.

Application procedures

Sprayers

- Sprayers that can deliver enough litres per hectare for adequate coverage are satisfactory for applying emulsion-type insecticides.
- If using 2,4-D or related herbicides, clean the sprayers thoroughly with detergent containing ammonia to prevent crop damage.
- Adequate agitation is essential when applying wettable powder formulations.
- Pumps should be capable of delivering the flow and pressure required as well as being compatible with materials sprayed.
- Keep in mind that the higher the pressure, the greater the danger of drift to other crops.
- Calibrate your sprayer at least twice during the growing season with each set of nozzles used. The wear on nozzles and other parts will alter the amount of spray delivered.
- Check all nozzles for flow rate at least once a year. Replace nozzles when their output is 10% greater than rated output.
- For information on calibration, see the current OMAF Publication 75, *Guide to Weed Control.*

See the calibration calculator on the OMAF website.

Aerial application by airplane or helicopter

Any person who applies pesticide from an aircraft in Ontario must hold an aerial exterminator licence. As well, a permit is required to purchase and apply pesticides by air for the following:

- applications to surface water, e.g., ponds, lakes, rivers (exceptions in some cases)
- applications to forests as defined in the Crown Forest Sustainability Act
- applications of any Schedule 1 or 5 pesticide or a Schedule 2 pesticide containing 2,4-D, 2,4-DB, mecoprop, MCPA, MCPB, dichlorprop, dicamba, picloram, paraquat or trichlopyr, except when applications are made to agricultural land.

Be sure that any pesticide you apply by air has specific instructions for aerial use on the label.

Take extra precautions when using insecticides applied by air that are toxic to honeybees, such as Sevin (carbaryl).

Sprayer calibration

A very important part of integrated pest management, sprayer calibration:

- ensures that the proper amount of pesticide is applied
- ensures uniform pesticide application and coverage
- minimizes leftover tank mixtures, which can be difficult to dispose of.

Field boom-type sprayer calibration

These five steps will help you calibrate your boom sprayer application rates in L/ha.

1. Measure the time.
   - Place 2 stakes 50 m apart in the field.
   - Select the gear and throttle setting (rpm) at which you plan to spray. Half-fill the sprayer with water.
   - Drive the distance between the stakes three times, timing each pass. Each time, make sure the tractor is at the desired speed as you pass the first stake and maintain this speed until you pass the second stake.
   - Note the average time of the 3 passes.

2. Measure the average nozzle output.
   - Park the sprayer with the PTO engaged and the throttle adjusted to reach the PTO speed set in the test run.
   - Adjust the pressure regulator to the desired working pressure with full flow to the boom.
   - Collect the output from each nozzle for the average length of time needed to travel the 50 m in the test run.
   - Enter the nozzle outputs into the equation below.
   - Clean or replace any nozzle more than 5% above or below the average output.
   - Measure the nozzle spacing in metres.
   - Use the following formula to determine the sprayer output:

$$\text{sprayer output (L/ha)} = \frac{\text{average nozzle output (mL)}}{\text{nozzle spacing (m)}} \times 0.2$$

3. Calculate the area sprayed after each tank of spray solution is applied. Re-check the sprayer calibration after each tank of spray is applied by dividing the volume sprayed by the area sprayed. The nature of some products may slightly alter the calibration from that of clean water.

To measure in litres/acre or gallons/acre, use this conversion guide:

litres/ha x 0.4	=	L/ac
litres/ha x 0.09	=	Imp. gal/ac
litres/ha x 0.11	=	U.S. gal/ac

Sample calculation

Average time to travel 50 m	=	24.5 sec
Average amount of liquid collected per nozzle for 24.5 sec	=	525 mL
Nozzle spacing on the boom	=	0.5 m
Application rate = 525 mL X 0.2 ÷ 0.5 m	=	210 L/ha
210 L/ha x 0.4	=	84 L/ac
210 L/ha x 0.09	=	18.9 Imp. gal/ac
210 L/ha x 0.11	=	23 U.S. gal/ac

Handheld or backpack sprayer calibration

Many people use small, handheld spray guns or backpack sprayers for treating problem areas or spraying areas that were missed. Calibrating these sprayers is as important as calibrating your field sprayer.

Method 1

1. Measure an area that is 100 m^2, e.g., 10 m x 10 m, or 25 m x 4 m.

2. Fill the spray tank with water. Mark the level on a measuring stick. Pump to the pressure that will be used during the pesticide application.

3. Spray the water over the 100 m^2 area. Walk at a steady pace, taking care to apply it as evenly as possible, just as you would when applying pesticide.

4. Measure the amount of water needed to refill the spray tank to the mark on the measuring stick. This amount will be the sprayer output per 100 m^2.

Method 2

1. Set 2 stakes 50 m (164 ft) apart in the field.

2. Half-fill the sprayer with water.

3. Walk the 50 m 3 times at a steady pace. Calculate your average time to travel the 50 m.

4. Measure the width of the band sprayed by the nozzle (in metres) at your walking pace.

5. Pump the sprayer for the same amount of time as calculated in step 3, collecting the liquid from the nozzle in a measuring device.

6.

$$\text{Application rate (L/ha)} = \frac{\text{mL liquid/nozzle}}{\text{band width (metres)}} \times 0.2$$

Method 3

1. Partially fill sprayer. Pump to the pressure you will use during the pesticide application.

2. Spray to determine width of swath (in metres).

3. Walk at a steady pace for 15 sec. Measure the distance (in metres).

4. Multiply spray width times distance travelled to provide the area (in square metres) sprayed in 15 sec.

5. Spray into a measuring device for 15 sec to determine the amount of solution sprayed in 15 sec.

6.

$$\text{Application rate (L/ha)} = \frac{\text{amount sprayed}}{\text{area (length X width)}} = \frac{\text{L X 10,000}}{\text{square metres}}$$

To convert the application rate of any pesticide to the amount required for a small area, follow this guide (Ontario Pesticide Education Program Manual 1995):

dry measure: 1 kg/ha = 10 gm/100 m^2
liquid measure: 100 L/ha = 1 L/100 m^2

Pesticide information specific to turfgrass

Pest resistance to insecticides, fungicides and miticides

Many of the recommended pesticides have specific mechanisms of action, that is, they act on a single system or site in the organism. Do not use these materials repeatedly in a season. This increases the chances of pest resistance developing. Examples of these types of compounds are Senator, Rovral and Banner.

Pests are said to be resistant when they are able to survive exposure to rates of pesticides that previously controlled them. Generally, resistance to a pesticide develops after repeated exposure to a specific chemical. Resistance occurs because a few naturally occurring resistant individual pests survive after each spray, while the susceptible portion of the population is killed. These resistant survivors multiply and gradually replace the susceptible ones. Eventually only a resistant population remains.

The development of resistance to pesticides can occur very quickly. Do not use the same chemical repeatedly. Alternate chemicals or use them in combination with others that have a different mode of action. This practice reduces the likelihood of resistance developing.

Several pesticides may act similarly. Thus, alternating these compounds does not work. Use fungicides with different modes of actions. For example, you could alternate Heritage, Banner and Daconil.

Pesticide injury to crops

Although insecticides and fungicides are selected and formulated to avoid plant injury, damage can, under some conditions, still occur. In addition to the precautions mentioned in this publication, you should also:

- Apply sprays when the drying condition is fast. Some chemicals break down to components that injure plant tissues if they stay wet.
- Apply sprays when the temperature is below 27°C.
- Be particularly careful when plants have been under growth stress, such as prolonged periods of drought, excessive cloud cover, extremely low or high temperatures.
- Apply sprays soon after mixing. Some chemicals may undergo a chemical change if the sprays remain in the tank for a long time, like overnight. In other cases, the chemicals may settle out and clog the lines.

2. Soil Management and Fertilizer Use

Fertilizing is one of the key components of good turf management and integrated pest management. A well balanced fertilizer program will help turf avoid stress and disease. The best way to determine turf fertilizer needs is to do a soil test.

Soil testing

Soil testing and plant analysis are currently the most accurate tools available to determine how much fertilizer, lime, phosphorus and potassium to apply to turf areas. Where possible, use both methods.

Submit turf soil samples to a commercial laboratory accredited by OMAF for analysis. All analyses are on a fee-for-service basis. The labs must meet and maintain established levels of proficiency on the basic tests to keep their accreditation. See Appendix D on page 68 for a complete list of accredited labs.

Recommendations are made on the basis of four types of turfgrass management programs:

- greens and tees
- fairways, athletic fields and lawns
- nursery sod
- low-use turf.

Soil sampling

The following steps ensure the quality of the sample you take for testing:

- use a soil sampling tube, shovel or a cup changer
- take the core to a depth of 15 cm on all turf except greens and tees
- for greens and tees take a depth of 7.5 cm, which is more closely related to the active root feeding zone of bentgrass
- take at least 20 cores (10 to 15 on greens) for each sample
- since greens and fields are highly variable, make sure each unit has a separate sample
- sample problem areas separately
- discard the thatch layer of the core, then mix the cores thoroughly in a clean plastic pail.
- fill the sample box and fill out an information sheet specifying the type of turf for which you need a recommendation.

When to sample

On well-established turfgrass areas, representative sampling every two to three years may be enough. On newly established areas and on sand root zones, test annually to monitor the nutrient status more closely. Nitrogen and potash levels can change quickly in sand root zones or if clippings are removed.

Soil tests from other labs

Each year there are requests to interpret soil test results from other labs. If the lab uses the identical chemical tests used by the OMAF-accredited service and expresses their test results in the same units, the OMAF fertilizer requirements for phosphate and potash can be used.

However, this is rarely the case. Only soil tests using chemical extractants that have been calibrated on Ontario soils can provide accurate fertilizer recommendations. A number of labs provide tests such as exchange capacity, nitrogen, iron, copper and sulphur. The OMAF soil testing service does not do these tests because they do not contribute to better fertilizer recommendations. Research has shown that using exchange capacity to adjust recommendations on Ontario soils can lead to less reliable guidelines than are now provided.

Micronutrient tests

Micronutrient deficiencies in turf are rare.

The OMAF service does test for manganese and zinc. No acceptable soil test for copper or boron is available in Ontario. Plant analysis can give some indication of micronutrient status.

With the exception of some areas in northwestern Ontario, there appear to be adequate supplies of sulphur for crop production.

Take great care to prevent contamination of soil samples you are having tested.

- Do not use galvanized (zinc plated) soil sampling tubes to take soil samples for micronutrient tests.
- Do not use metal containers to collect and mix samples.

Plant analysis

Plant analysis measures the nutrient content of plant tissue. By comparing the analysis results against the "normal" range, you can determine whether nutrient supply is adequate in your turfgrass. See *Table 2-1. Desirable nutrient concentrations in dried turfgrass clippings.*

Plant analysis is a useful supplement to soil testing in evaluating the fertility status of turfgrasses. It is quite independent of soil testing and can provide a valuable second opinion, especially for phosphorus, potassium, magnesium and manganese. It is also the only test for nitrogen and the micronutrients. Iron analysis is not likely to be useful.

Plant analysis has limits. Expert help in interpreting the results is often needed since plant analysis does not always show the cause of the deficiency or the amount of fertilizer required to correct it.

Table 2-1. Desirable nutrient concentrations in dried turfgrass clippings

Element	Normal range
N	2.5 – 6.0
P	0.15 – 0.55%
K	0.9 – 4.0%
Ca	0.2 – 4.5%
Mg	0.15 – 1.0 %
Mn	20 – 140 ppm
Zn	10 – 100 ppm
Cu	5 – 30 ppm
B	3 – 30 ppm

This is a guideline until more information is available. Nutrient levels vary depending on turfgrass species.

Sampling

To collect a proper sample:

- you need about 500 grams of clippings
- take the clippings from the mower baskets
- do not contaminate the sample with soil, as even a small amount of soil will make the results invalid, especially for manganese.
- do not topdress, fertilize or apply any chemical sprays before taking the clippings as this will contaminate them
- dry the samples immediately by placing them in a thin layer on a clean surface, stirring occasionally to help them dry uniformly
- place them in a sample bag
- deliver them to the lab immediately.

A soil sample taken at the same time as the clipping will provide additional results for comparison.

Nutrient management plans

A nutrient management plan matches the nutrients available from manure, from cover crops or legumes ploughed down, from commercial fertilizer and from the soil to the nutrients required by the crop. Analysis of the nutrients in the manure along with soil test results and crop requirements help to determine application rates and additional commercial fertilizer requirements.

Following a nutrient management plan optimizes the nutrients applied to the crop for crop yield and profitability while reducing the risk of surface or groundwater contamination from nitrogen or phosphorus.

Regulations under the Nutrient Management Act require some farmers to complete nutrient management plans (NMPs). This applies to new livestock operations and to operations expanding above 300 nutrient units. The regulations will apply to existing operations that generate 300 nutrient units or more on July 1, 2005.

Other farms that receive and apply nutrients may come under a requirement to complete an NMP at a future date. Outside of the legal obligation, many farmers are completing nutrient management plans because it saves them money and improves the management of inputs.

Nitrogen

There is no satisfactory soil test available for nitrogen (N) under Ontario conditions.

Nitrogen is the element the turf plant uses in the greatest quantities. Nitrogen promotes the dark green colour, leaf and blade development and turf density. Nitrogen plays a role in disease development. Plants deficient in N are susceptible to some diseases (red thread and dollar spot). Turf with excess nitrogen is susceptible to other diseases such as Pythium blight and brown patch. The key to a good nitrogen fertility program is to have balanced N.

The amount of nitrogen fertilizer used strongly affects the colour, density and vigour of turf. Adjust the amount of nitrogen for the desired growth response. Use the recommendations in *Table 2-2. Nitrogen requirements for turf and nursery sod* as a guideline.

A common rule of thumb for bentgrass greens during the summer is to use nitrogen at a rate at which two baskets of clippings are removed per day per 550 m^2. The specific application rate depends on the type of nitrogen carrier used. More frequent applications are required with quick-release and less frequent with slow-release carriers.

When to apply nitrogen fertilizer depends on such factors as:

- turf species
- turf use
- turf conditions
- soil type
- desired level of quality
- weather conditions
- length of growing season
- whether or not clippings are removed
- type of fertilizer used.

Table 2-2. Nitrogen requirements for turf and nursery sod

Greens, tees	Nitrogen to be recommended by turf specialist; not more than 400 kg N/ha in 6–8 applications. 250 kg N/ha is usually enough for established greens. Not more than 50 kg N/ha per application.*
Lawns, fairways, athletic fields	Nitrogen to be recommended by turf specialist; not more than 200 kg N/ha in 4 applications if clippings are left on. Not more than 50 kg N/ha per application.
Low-use turf	Nitrogen to be recommended by turf specialist; 50 kg N/ha applied once per season.*
Nursery sod	Prior to final cultivation before seed bed preparation and where the soil is a coarse texture, apply 90 kg N/ha. Where soil is medium or fine texture, is high in organic matter, or has a history of luxuriant growth, reduce the initial application to 50 kg N/ha. On turf with less than 85% groundcover, apply 70 kg N/ha as early as feasible in the spring after seeding. Reduce the rate to 35 kg N/ha where vigorous growth is evident. In mid or late June apply 50 kg N/ha. Withhold further applications until 3 weeks prior to harvesting at which time apply 35 kg N/ha. Where sod is held over a second winter apply 45 kg N/ha in September, early November, late May and every 10 weeks until harvest.

*Divide kg/ha by 100 to obtain kg/100 m^2.

Nitrogen equivalency

Fertilizer recommendations are often based on actual (elemental) nitrogen. Use the following calculation to determine the application rate of any nitrogen fertilizer formulation.

To apply 0.5 kg N/100m^2

$$\frac{100}{\%N \text{ in fertilizer}} \times 0.5 \text{ kg/100m2} = \text{kg fertilizer/100 } m^2$$

Another method is to use *Table 2-3. Nitrogen equivalency* to determine the amount of fertilizer (with any given per cent nitrogen) needed for an application rate of 0.5 kg N / 100m^2.

Table 2-3. Nitrogen equivalency

To obtain 0.5 kg N/100 m^2	
N% in fertilizer	kg/100m^2
5	10.00
6	8.33
7	7.14
8	6.25
9	5.55
10	5.00
11	4.55
12	4.16
13	3.84
14	3.57
15	3.33
16	3.12
17	2.94
18	2.77
19	2.63
20	2.50
21	2.38
22	2.27
23	2.17
24	2.08
25	2.00
26	1.92
27	1.85
28	1.79
29	1.72
30	1.67
31	1.61
32	1.56
33	1.50
34	1.47
35	1.43
46	1.09

Nitrogen sources

Quick-release sources of nitrogen fertilizers are generally less expensive than slow-release. However, they are also more prone to leaching and have a higher burn potential. Therefore, if used, apply these sources of nitrogen more frequently but at lower rates and water them in after application.

Slow-release sources of nitrogen are generally more expensive but less prone to leaching, have a lower burn potential and are available more slowly.

A large selection of nitrogen sources is available. They can be divided into two categories: inorganic and organic. Organic is subdivided into synthetic organic (quick release and slow release) and natural organic.

Inorganic nitrogen

Inorganic nitrogen contains no carbon. These nitrogen materials include ammonium nitrate, ammonium sulphate, and potassium nitrate. Inorganic N is water soluble, quick release. It has high burn and high leaching potential and is inexpensive.

Synthetic organic nitrogen

Synthetic organic fertilizers are chemically based and originate from atmospheric nitrogen. They are classed as organic because they contain carbon. This category has quick-release and slow-release forms. Urea is the only turf fertilizer that is a synthetic organic and a quick-release source of nitrogen. Urea is also inexpensive, has a low burn potential and can be used as a liquid fertilizer.

Slow-release synthetic organic nitrogen

Slow-release forms of synthetic organic nitrogen are manufactured by two technologies, either by a chemical reaction with urea or by encapsulating urea. These sources of nitrogen are slow release, have a low burn potential and low leaching potential. They are expensive relative to urea.

The products that result from chemical reaction with urea are ureaformeldehyde (UF), also called methylene urea (MU), isobutylidine diurea (IBDU), and triazones.

Methylene ureas combine ureas with carbon and hydrogen, which forms chains of molecules. The shorter the chain, the faster the N release and the higher the burn potential. The longer the chain the slower the N release and the lower the burn potential. This type of fertilizer requires microbial activity to release the nitrogen.

Isobutylidine diurea is formed by reacting isobutylaldehyde and urea. The nitrogen is released via hydrolysis. The size of the particles controls the

nitrogen release rate: the smaller the particle size, the quicker the release.

Triazone is produced by the reaction of urea and formaldehyde, which forms a cyclic methylene urea. Triazone is released through microbial degradation.

Coated ureas

Coated ureas are urea pellets surrounded by a less soluble sulphur or polymer coat. Water has to penetrate and crack the coating to release the nitrogen in sulphur-coated urea (SCU). Some SCU products are coated with a wax sealant that needs microbial activity to break it. The coating thickness controls the release rate of SCU. SCU fertilizers are relatively inexpensive. Polymer-coated ureas (PCU) are more expensive than SCU but provide a more controlled nitrogen release.

Natural organic nitrogen sources

The use of natural organic sources of nitrogen has increased over the last decade. Natural organics have a low burn potential, a slow release rate, low leaching potential and rely on microbial activity for nitrogen release. The drawback for natural inorganic fertilizers is low N rate and the high cost. The three categories of organic N fertilizers are sewage sludge based, animal based and plant based.

Phosphorus and potash

Apply phosphorus and potassium (potash) to turf areas based on a soil test. The requirements for these nutrients are in *Table 2-4. Phosphorus and potassium requirements for turf and nursery sod*. Do not use this table with soil test readings from other labs unless their methods are identical to those used by the OMAF-accredited lab.

Table 2-4. Phosphorus and potassium requirements for turf and nursery sod

Soil phosphorus (0.5 M sodium bicarbonate)	Greens, tees, fairways, lawns, athletic fields	Low-use turf	Nursery sod	Soil potassium (IM amm. acetate)	Greens, tees	Fairways, lawns, athletic fields	Low-use turf	Nursery Sod
(ppm P)	Phosphate (P_2O_5) required — kg/ha*			(ppm K)	Potash (K_2O) required — kg/ha*			
0–3	370 L	90 L	230 L	0–15	400 L	200 L	90 L	140 L
4–5	360 L	80 L	210 L	16–30	360 L	180 L	80 L	120 L
6–7	350 L	70 L	200 L	31–45	320 L	160 L	70 L	80L
8–9	340 L	60 L	190 L	46–60	280 L	140 L	50 L	60 L
10–12	320 L	40 M	170 L	61–80	200 L	100 L	30 M	50 M
13–15	300 L	30 M	150 L	81–100	160 L	80 M	20 M	40 M
16–20	260 L	20 M	130 M	101–120	120 M	60 M	20 M	30 M
21–25	220 M	0 H	110 M	121–150	80 M	40 M	0 MH	30 M
26–30	170 M	0 H	90 M	151–180	40 M	40 M	0 VH	0 H
31–40	120 M	0 VH	70 H	181–210	0 H	0 H	0 VH	0 VH
41–50	70 H	0 VH	50 H	211–250	0 VH	0 VH	0 VH	0 VH
51–60	40 H	0 VH	40 H	250 +	0 E	0 E	0 E	0 E
61-80	0VH	0 E	30 H					
80 +	0 E	0 E	0 E					

*Rates are total yearly applications. Not more than 90 kg/ha should be applied in any one application except for nursery sod, which may receive the total yearly amount in one application before seeding.
L = low; M = medium; H = high; VH = very high; E = extremely high

Phosphorus is important in establishing turfgrasses. Where a soil test is not available, use the following guidelines to obtain a rough estimate of requirements:

- Where the turf has been fertilized regularly for a number of years or heavily in recent years, use the rates of phosphate and potash recommended for the medium soil test rating.
- If the field has received little fertilizer in the past, use one of the rates recommended for a low soil test rating.

Phosphorus does not leach readily from the soil and may accumulate to very high levels. Potash leaches to some degree from sandy and organic soils. In contrast, nitrogen leaches quite readily.

Table 2-5. Phosphorus sources

Phosphorus sources	P_2O_5 %
Superphosphate	20
Triple superphosphate	46
Monoammonium phosphate (11-52-0)	52
Diammonium phosphate (18-46-0)	46

Table 2-6. Potassium sources

Sources	K_2O %
Potassium chloride (muriate)	60–62
Potassium sulphate	50
Sulphate of potash magnesia (11% of Mg)	22
Potassium nitrate	44

Applying fertilizer

Turf use, conditions and soil type

Areas that are used and irrigated a lot require more nutrients. (Nitrogen and potassium are the most affected.) Older turf requires less nitrogen than younger turf. Do not apply more than 0.5 kg N / 100 m^2 per application (see Table 2-2 on page 21).

It is better to apply fertilizer more frequently at a lower rate. This is especially true when applying fertilizer in the summer. However, granular fertilizer applications on golf course greens of less than 0.125 kg N / 100 m^2 could result in uneven coverage and "freckling" of the turf.

Type of fertilizer

Nitrogen may be obtained from a complete fertilizer or by using ammonium nitrate, urea or slow-release nitrogen materials. Where water-soluble ammonium nitrate or urea is used, water it in to avoid foliar burn.

Timing of application

Avoid fertilizing during periods of heat, drought stress or when conditions favour active disease development.

Early spring fertilization is not recommended as this tends to promote excessive shoot growth. Delay applying nitrogen until early June. Applying fertilizer high in nitrogen between October 20 and November 5 generates better root growth, early green-up and moderate growth rates in the spring. Delay applying if fall weather is warmer than normal. For low-use turf that is only fertilized once a year, early fall application is recommended. Rates should be kept low enough to prevent lush growth late in the fall.

Fall fertilization

Early fall is an important season for turf growth and recovery, and nitrogen fertilization is needed to accomplish this. Late fall fertilization also helps turf to overwinter. With the onset of fall temperatures, shoot growth stops but roots continue to grow and accumulate reserves of carbohydrates. This allows the plant to store carbohydrates, which helps it survive the winter and promotes early green-up in the spring.

Advantages

Fertilizing turf in the fall offers many advantages:

- increased tiller formation resulting in dense turf that resists weed infestation
- turf that stays green longer in the fall
- increased winter hardiness
- early spring green-up
- no early spring fertilizer needed and the flush of soft spring growth avoided
- the first spring fertilizer application can be delayed until late May or early June.

Timing

Fall fertilization of turf is a two-step process. Timing for the first application is mid-August to mid-September. You should not apply nitrogen from mid-September to late October.

Timing of the late fall nitrogen application is crucial since the period that produces optimal benefits may only last a couple of weeks. With improper timing, the fertilizer is either detrimental or ineffective.

An early application (mid-September to end of October) forces succulent growth and tissue hydration, which increases the turf's susceptibility to winter disease and low-temperature kill. An application of nitrogen fertilizer when turf has already gone dormant does not produce the carbohydrates that promote root growth or allow the plant to produce and store carbohydrates that result in early spring green-up.

The optimal time for the second application is when the temperature has steadily lowered to 10°C. The turf is still green, the shoots are no longer growing, the roots are still growing, and it is well before dormancy. Timing of application in the Guelph area is late October to early November.

Application schedule

Fall fertilization programs should be divided into two parts:

- first application: 0.3 to 0.5 kg N / 100 m^2 in mid August to mid September
- second application: 1.0 to 1.5 kg / N / 100 m^2 in late October to early November with a high-nitrogen, low-potassium fertilizer. The amount of N is based on the colour and the density of the turf in the late fall.

Any nitrogen applied in early and late fall is included in the total N recommended in Table 2-2 on page 21.

The use of potassium and phosphorus for fall fertilizer application should be determined by a soil test.

Fertilizer selection

Choose a water-soluble or quick-release fertilizer that allows the nitrogen to be available to the plant regardless of soil temperature. Some examples are urea, ammonium nitrate, ammonium sulphate, potassium nitrate and ammoniated phosphates and IBDU. See *Table 2-7. Rating of some nitrogen sources for suitability for late fall fertilization.*

Table 2-7. Rating of some nitrogen sources for suitability for late fall fertilization

Nitrogen source	Analysis	Source of N	Suitability for late fall
Quick release			
Urea	46-0-0	urea	excellent
Ammonium nitrate	33-0-0	AN	excellent
Ammonium sulfate	21-0-0	AS	excellent
Ammonium phosphate	18-46-0	DAP	good
Urea formiedehyde or methylene urea reaction products			
Nutralene	40-0-0	methylene ureas	good
Methylene urea	39-0-0	methylene ureas	good
Nitroform (gran.)	38-0-0	ureaform	poor
Natural organics			
Milorganite	6-2-0	activated sludge	poor
Sustane	5-2-4	composted turkey litter	poor-fair
Ringer products	6-1-3	seed & bone meals, blood	poor
IBDU			
Isobutylidine diurea	31-0-0	IBDU	good-excellent
Coated materials			
Sulphur-coated urea	varies	urea	fair-good

Environmental considerations

Fall fertilization has many advantages, but there are environmental risks associated with it. Late fall, winter and early spring brings precipitation that recharges the aquifers. Potential leaching of soluble substances such as nitrate is increased during these periods. It is no longer recommended on highly permeable soils, such as sand, to fertilize late in the fall with a quick-release N source. In these situations, slow-release sources such as IBDU and sulphur-coated ureas should be used, which prevent leaching of nitrates.

Municipal sewage biosolids

Municipal sewage biosolids are a source of nitrogen, phosphorus and organic matter that can be used to produce sod. A site receiving sewage biosolids must have a certificate of approval issued by the Ontario Ministry of the Environment.

Before sewage biosolids can be applied to land it must qualify under the Environmental Protecton Act Regulation 347 and the Nutrient Management Act Regulation 267/03. These regulations set site and application criteria and the waiting period between applying sewage biosolids and harvest. The period between applying sewage biosolids and harvesting commercial sod is 12 months.

For more information refer to OMAF factsheet *Land Application of Municipal Sewage Biosolids for Crop Production*, Order No. 00-023.

For more information on sod production visit the OMAF turf page site at www.omaf.gov.on.ca.

Adjusting soil pH

Soil pH is a measure of acidity or alkalinity on a scale from 0 to 14. The middle of the scale (7.0) is neutral, with values below 7.0 being increasingly acid and values above 7.0 increasingly alkaline. Most Ontario soils are between 5.0 and 8.0. As soil acidity increases, the solubility of elements such as iron and manganese also increases. Most turf species grow well in soil pH 5.5–7.5.

Raising pH

Lime is used to raise pH and is useful where soil pH is low. General lime applications for most crops, based on buffer pH, are listed in *Table 2-8. Lime requirements to correct soil acidity based on soil pH and soil Buffer pH.*

Buffer pH

Different soils with any one soil pH value, for example 5.2, require different amounts of lime to bring the pH to a particular desired level, that is, 6.0. This depends chiefly on the clay and organic matter content of each soil.

The soil pH determines which soils need to be limed, but a separate soil test, the buffer pH, determines the amount of lime required. For soils needing lime (based on soil pH), use *Table 2-8. Lime requirements to correct soil acidity based on soil pH and soil Buffer pH* to determine the amount of lime needed to reach different "target" soil pH values required for different crops.

Table 2-8. Lime requirements to correct soil acidity based on soil pH and soil Buffer pH

Buffer pH	Target soil pH = 6.5 Lime if soil pH < 6.1	Target soil pH = 6.0 Lime if soil pH < 5.6
	Ground limestone required – t/ha (Based on Agricultural Index of 75)	
7.0	2	0
6.5	3	2
6.0	9	6
5.5	17	12
5.0	20	20

Limestone quality

Calcitic limestone consists largely of calcium carbonate. Dolomitic limestone is a mixture of calcium and magnesium carbonates. Use dolomitic limestone on soils with a magnesium soil test of 100 or less as it is an excellent, inexpensive source of magnesium. On soils with magnesium tests greater than 100, either calcitic or dolomitic limestone may be used to increase soil pH.

Two main factors affect the value of limestone for soil applications. One is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. This is called the "neutralizing value" and is expressed as a percentage of the neutralizing value of pure calcium carbonate. A limestone that will neutralize 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90. In general, the higher the calcium and

magnesium content of a limestone, the higher the neutralizing value.

The second factor that affects the value of limestone as a neutralizer of acidity is the particle size. Limestone rock has much less surface area to react with acid soil than finely powdered limestone. Hence it neutralizes acidity much more slowly — so slowly that it is of little value.

Lowering pH

Sulphur can be used to lower pH. See *Table 2-9. Soil acidification to pH 5.0 with sulphur*. Do not apply more than 2 kg sulphur per 100 m^2 on established turf. Lower rates should be used on high-sand-content soils such as putting greens. Soils with pH above 7.0 frequently contain too much lime to use sulphur to lower the pH.

Table 2-9. Soil acidification to pH 5.0 with sulphur

	Soil type	
Initial pH	Sand (kg/100m^2)	Loam (kg/100 m^2)
7.0	7.4	22.6
6.5	6.0	17.5
6.0	4.0	12.0
5.5	2.0	6.0

kg of elemental sulphur per 100 m^2 for each of 2 successive years.

Temperature, moisture and aeration conditions affect the rate of pH change. The best time to apply materials to adjust the pH is spring, late fall or after cultivation practices such as coring. Perform major pH adjustments before your turf is established. This way it will be incorporated into the root zone.

Soluble salts in soil

High concentrations of water-soluble salts in soils can prevent or delay germination of seeds and can kill established plants or seriously retard their growth.

Ontario soils are naturally low in soluble salts. Soluble salts therefore rarely cause a problem in crop production and are not routinely measured in soil tests.

Excessive applications of fertilizers, run-off of salts applied to roads and chemical spills are some reasons soluble salts are found in soils. If the amount of water is small, a given amount of salt in a soil creates a higher soil-water-salt concentration. Soluble salts also interfere with the uptake of water by plants. For these reasons, plant growth is most affected by soluble salts in periods of low moisture supply (drought).

Soluble salts can be measured readily in the lab by measuring the electrical conductivity of a soil-water slurry. The higher the concentration of water soluble salts, the higher the conductivity. *Table 2-10. Soil conductivity reading interpretation* provides an interpretation of soil conductivity readings in Ontario field soils in a 2:1 water-soil-paste mixture, the procedure used by the OMAF-accredited labs.

Table 2-10. Soil conductivity reading interpretation

Conductivity "salt" reading millisiemens/cm	Rating	Plant response
0 – 0.25	L	Suitable for most plants if recommended amounts of fertilizer used.
0.26 – 0.45	M	Suitable for most plants if recommended amounts of fertilizer used.
0.46 – 0.70	H	May reduce emergence and cause slight to severe damage to salt sensitive plants.
0.71 – 1.00	E	May prevent emergence and cause slight to severe damage to most plants.
1.00	E	Expected to cause severe damage to most plants.

L -low; M-medium; H-high; E- extremely high
For greenhouse soils, the OMAF-accredited soil test uses a larger soil sample and measures conductivity on a saturation extract. For greenhouse crops using that method, conductivity readings up to 3.5 millisiemens/cm are acceptable.

For more in-depth information of soil management and soil fertility, please refer to OMAF Publication 611, *Soil Fertility Handbook*.

3. Integrated Pest Management for Diseases and Insects

Integrated pest management (IPM) is a process that uses all necessary techniques to suppress pests effectively, economically and in an environmentally sound manner to sustain healthy landscapes. IPM employs a two-pronged approach: managing turfgrass to prevent problems and using "thresholds" to decide how and when to treat pests.

In an IPM program, turf managers use regular inspections, called monitoring, to collect the information they need to make treatment decisions. A central idea in IPM is that a treatment is only used when pest numbers justify it, not as a routine measure. Applying pesticides according to a schedule based on calendar dates is rarely, if ever, done in IPM programs. This eliminates unnecessary pesticide use without sacrificing results.

Integrated pest management

Integrated pest management is a process for suppressing pests that uses a combination of techniques, including but not limited to:

- planning and managing ecosystems to prevent organisms from becoming pests
- identifying potential pest problems
- monitoring and recording populations of pests and beneficial organisms, pest damage and environmental conditions
- using "thresholds" to make treatment decisions
- reducing pest populations to acceptable levels using strategies that may include a combination of biological, physical, cultural, mechanical, behavioural and chemical controls
- evaluating the effectiveness of treatments.

— adapted from the Pest Management Regulatory Agency

Cultural control

Many factors influence the occurrence of insect and disease problems on turf. Damage can be minimized by good cultural practices that encourage vigorous turf growth, producing turf that is less susceptible to insect and disease problems.

Irrigate

Water infrequently and deeply.
Time irrigation to minimize leaf wetness.
Syringe (water very lightly) to reduce heat stress.
Ensure adequate air movement and sun to dry off turf quickly.

Fertilize

Apply phosphorus (P) and potassium (K) based on a soil test.

Adjust nitrogen (N) fertilization according to species and time of year.

Use slow-release sources of nitrogen.

Use an appropriate quantity of nitrogen to reduce dollar spot, red thread, brown patch and *Pythium*.

Mow

Mow as high as possible.

Sharpen mower blades frequently.

Use a lightweight mower if possible.

Remove clippings from greens only.

Never remove more than one third of the leaf blade.

Aerate

Aerate at least twice year to reduce compaction, improve water and pesticide infiltration, improve soil profile, increase soil oxygen and break down thatch.

Use disease and insect-resistant turf species and varieties when possible. Several cultivars of turf-type perennial ryegrass, tall fescue and fine fescue contain endophytes. They are fungi that grow inside the turfgrass plant. These endophytes give turfgrass some resistance to surface-feeding insects such as chinch bugs, bluegrass billbugs, sod webworm and cutworms.

Many improved cultivars of different turf species have been bred for improved disease resistance. Consult your local seed company or the National Turfgrass Evaluation Program test results (www.ntep.org) for more information.

Other elements to an integrated approach to pest control on turf include:

- maintaining balanced fertility and soil pH
- avoiding drought stress
- controlling thatch
- undertaking proper mowing and irrigation practices.

Foliar diseases

Foliar diseases can be prevented by reducing the period of leaf wetness. To accomplish this:

- water turf during the day rather than at night
- reduce shade conditions
- increase air circulation.

Monitoring

Frequent monitoring for diseases and insects is critical for effective turf pest management. It allows for early detection of the pest problem before extensive turf damage occurs.

Observe the parts of the plant that are being damaged. Note symptoms that may occur, such as yellowing or browning of leaves, thinning of turf, dieback or wilting, patchy appearance or the presence of insects or visible mycelium. Some disease and insect problems are more prevalent on certain turfgrass species. Knowing the main pest problems of a specific species may help diagnose the problem.

Timing

Proper timing of chemical applications is critical for achieving pest control. Be aware of the season of occurrence, life cycle and damaging stage of the pest. This may influence your selection and application of a control method. A summary can be found in *Table 3-1. Turf insects — Summary of life cycles, habitat, damage and distribution factors.*

For more detailed information on turf disease and insect identification and biology refer to OMAF Publication 162, *Diseases and Insects of Turfgrass in Ontario.*

If you cannot identify an insect or disease pest, you can submit samples to the Guelph Turfgrass Institute Diagnostics. A sample submission form and a fee schedule can be found on the GTI website at www.uoguelph.ca/GTI.

For more information on integrated pest management of diseases and insect, monitoring, timing of monitoring, monitoring techniques, sample monitoring forms, pest identification and IPM templates consult OMAF Publication 816, *Turf IPM Manual* and OMAF Publication 162, *Diseases and Insects of Turfgrass in Ontario.*

Chemical control

A large variety of chemicals (and some microorganisms) are registered as pesticides in Ontario for use on turf.

Pesticides are defined as any substances used to kill, control, repel or manage insects, rodents, fungi, weeds and other living things considered to be pests. Pesticides vary greatly in their toxicity and the way they work.

In IPM programs, use pesticides only after careful assessment shows that they are the best control for the situation. Applying pesticides only when monitoring shows that the threshold has been reached is economical and eliminates unnecessary pesticide use. Apply pesticides only with a properly calibrated sprayer.

When you decide to use pesticides, choose the most suitable formulations and methods of application. Take all possible precautions to prevent the exposure of people and non-target organisms to the pesticide. To limit the negative effects of pesticides:

- choose pesticides that present the least short- and long-term health risk to humans
- choose pesticides that have the lowest environmental impact, usually because of short residual effects or because they specifically affect target pests
- choose application methods that limit the amount of pesticide used and limit pesticide drift (shrouded sprayers)
- limit treatments to only the plants or sites where pests are a problem (spot treatment)
- notify anyone who might enter a treated area so that they can avoid exposure by following the posted regulations.

For specific pesticide recommendations for insects and disease for Ontario see Chapter 5. For safe use guidelines for pesticides refer to Chapter 1.

Table 3-1. Turf insects — Summary of life cycles, habitat, damage and distribution factors

	Damaging stage	Overwintering stage	Yearly generations	Distribution factors
Soil inhabiting insects (attack roots)				
Black turfgrass ataenius	grub	adult beetle	1–2	moist soil, closely mowed, bluegrass and bentgrass
White grubs	grub	adult beetle or larva	3-year cycle	prefer sandy soil
European chafer	grub	larva	1	throughout southern Ontario
Japanese beetle	grub	larva	1	found mainly in Niagara Peninsula and Windsor area
Bluegrass billbug	larva	adult weevil	1	prefers bluegrass
Thatch inhabiting insects (attack leaves and stems)				
Annual bluegrass weevil	larva	adult weevil	1	prefers annual bluegrass
Hairy chinch bug	nymph, bug	adult bug	1	excess thatch, non-irrigated turf, high population found in fescues
Sod webworms, lawn moths	caterpillar	larva	2–3	
Cutworms	caterpillar	adult moths fly in from southern locations each spring	2	around aeration holes on moist, closely mowed turf
European cranefly	larva	larva	1	found throughout many areas of southwestern Ontario on home lawns and golf courses
Turfgrass scale	mature nymphs	mature nymphs	1	occurs on Kentucky bluegrass, fine fescue, creeping bentgrass. Often found on sodded lawns, 3–5 years old

4. Integrated Pest Management for Weeds — Lawns, Parks, Golf Courses and Sod Farms

The major species of broadleaf weeds infesting lawns in Ontario are dandelion, plantain, black medick, chickweed, prostrate knotweed, mallow, henbit, ground ivy and white clover. The major grassy weeds are crabgrass, annual bluegrass, quackgrass, orchard grass and bentgrass.

Cultural practices

The easiest, cheapest and most effortless way to keep lawns free of weeds is to encourage vigorous growth of turfgrass. Most weeds cannot compete in a dense, healthy turf. Growth practices that encourage vigorous grass growth discourage weed infestations. Such practices include proper irrigation and drainage, use of fertilizers, insect and disease control, and the use of the correct type of turfgrass for the situation.

Mowing

Mowing stimulates bud development and tillering, making the sod thick and dense. Cut commonly grown grasses such as the fescues, bluegrasses and turf-type perennial ryegrasses to a height of 4–6 cm. Invasion by weeds may occur if grasses are cut shorter than 4 cm.

Avoid scalping the turf when cutting around trees and flowerbeds. Do not remove more than one third of the leaf area when mowing. Mowing too often may reduce the carbohydrate reserves of the turf, reducing its competitiveness. Mowing can also be used to remove annual weeds and eliminate seed production, reducing or preventing the spread of weeds.

Fertilizer

Fertilizer is particularly important in establishing a thick, dense and healthy turf sward. Too few nutrients applied to the turf leads to increased susceptibility to disease and insects. If this happens, the root system of the turf does not develop and the grass cannot withstand traffic or recover from injury. Too much fertilizer may lead to soft, weak grass that is prone to disease damage.

Watering

Watering is critical during periods of drought that may injure, kill or induce dormancy in the turf, thereby allowing weeds to become established. Irrigate weekly, using 2.5–4.0 cm of water per application to help produce deep-rooted turf.

Frequent light sprinkling will have the opposite effect on the grass roots. Light water applications encourage the germination and growth of shallow-rooted species such as crabgrass and creeping bentgrass. Too much irrigation water leads to infestation by yellow nut sedge and annual bluegrass. Remember to provide adequate watering near trees and hedges because they compete for available moisture.

Drainage

Drainage is important to ensure that waterlogging does not occur, so install adequate drainage if needed.

Compaction

Avoid compaction to prevent invasion by weeds that thrive in compacted soil. Knotweed and annual bluegrass often invade turfgrass where compaction, caused by excessive traffic, is a problem. While aeration practices do help, the best answer is to modify the area to reduce traffic. Immediate resodding or reseeding of damaged areas discourages weed infestations.

Turfgrass species

Select turfgrass species to match the growth conditions. For example, fescues are tolerant of low-light intensity in shaded areas under trees. Turf-type perennial ryegrass varieties are quick to establish in newly seeded areas and will crowd out germinating weeds. Kentucky bluegrass,

although slow to establish, is very competitive once established.

Mechanical removal

Mechanical removal of weeds can be very effective if weed populations are not too high. Weeds can be removed by pulling by hand or pulling with a knife or V-shaped spudding tool.

For more information on integrated weed management, including site categorization, weed thresholds, weed monitoring techniques in turf consult OMAF Pub. 816, *Turf IPM Manual*.

Chemical control

Chemical weed control is often the easiest, most effective and cheapest way to control annual and perennial weeds when populations are very high.

New turf

After seeding new turf, many annual weeds may emerge before the grass seedlings are up. If these young weeds are not controlled, they will shade and eventually crowd out much of the grass population. Mowing at a height of 6–8 cm will eliminate many such weeds. If they are extremely thick, 2,4-D at half the usual concentration (0.4–0.6 kg in 800 L water/ha) or mecoprop (0.4–0.6 kg in 400 L water/ha) can be used — but not before the grass has been up at least four weeks.

Established turf

Applications of 2,4-D are most effective in the spring or in September when the weeds are growing well. This treatment generally thins clover in lawns. Weeds not normally controlled by 2,4-D may be controlled by mecoprop or dicamba, or with combinations of one of these with 2,4-D. Mecoprop and dicamba are also sold in commercial mixtures with 2,4-D. See *Table 4-1. Classification of weeds according to response to various herbicides* for information on the response of common weeds to various herbicides.

Do not use mixtures containing dicamba close to shrubs or other susceptible ornamentals at rates above 0.425 kg/ha (active). Prepared mixtures of this chemical and 2,4-D are effective on a wide range of lawn weed species, including knotweed, which is not controlled by most other herbicides except when very young.

Broadleaf herbicides

2,4-D controls many broadleaf weeds including dandelion, lamb's quarters, mustards, peppergrass, pigweeds, plantains, shepherd's purse, smartweeds and vetch.

Mecoprop controls many 2,4-D and MCPA-tolerant weeds such as chickweeds, clovers, ground ivy and black medick and is generally safer to use on bentgrass than 2,4-D.

Dicamba controls broadleaf weeds including 2,4-D-tolerant weeds such as chickweeds, clover and young knotweed but does not adequately control plantain.

MCPA controls field horsetail, dandelion, lamb's quarters, mustards, plantains, shepherd's purse and wild carrot. Weeds tolerant to MCPA include chickweeds, clovers and black medick. Two and three-way mixes of these herbicides extend the spectrum of weeds that are controlled by using only one of these herbicides.

Grass herbicides

Betasan, Dimension and corn gluten meal-based products can be applied before crabgrass emerges in the spring, and Acclaim Super and Dimension can be applied after emergence. Corn gluten meal-based products can also be applied in the fall. *Table 4-1: Classification of weeds according to response to various herbicides* rates many common weeds according to their susceptibility to various herbicides.

Table 4-1. Classification of weeds according to response to various herbicides

Common name	2,4–D	MCPB	2,4-DB or MCPA	Mecoprop	Dicamba
aster (P)	I				
bedstraw (P)	R	I-R	R	I	R
bellflower (P)	R				
bindweed, field (P)	I	I	I	I	S-I
blueweed (B)	S-I	I		I	I
bracken fern (P)	R	R	R	R	I
buckwheat, wild (A)	I-R	I	I-R	I-R	S
burdock (B)	S	S	I		S
buttercup (P)	I-R	S-I	I**(I-R)	I	I
campion, bladder (P)	R	R	R	R	
carrot, wild (B)	S-R	S-R	R	I-R	S
catchfly, night-flowering (A)	R	R	R	R	
catnip (P)	S-I				
chickweed, common (A)	I-R	I	R	S	S
chickweed, mouse-eared (P)	I-R	I-R	R	S	S
chicory (P)	S	S-I	S-I*(R)	I-R	S
cinquefoil, rough (WA)	I				
cinquefoil, sulfur (upright c.), (P)	I				
cocklebur (A)	S	S	S	S	S
cockle, purple (A)	I-R	R	R		I
cockle, white (P)	R		I-R		I
daisy, ox-eye (P)	I	I	R	I	I
dandelion (P)	S	S	I*(R)	I	S
dock (P)	I	I	I	I	
evening-primrose (B)	S				
false flax (WA)	S	S	S	S	S
fleabane, annual (daily f.) (WA)	I	I	S-I		
fleabane, Canada (A)	S-I				
goat's-beard (B)	I				
goldenrod (P)	I	R	I	I	
goosefoot (A)	S	S	S	S	
goutweed (P)	R	R	R	R	
grasses (A and P)	R	R	R	R	
ground-ivy (creeping charlie) (P)	I-R	I-R		I	S
groundsel (A)	I	I			
hawkweed (P)	I-R	I-R			S-I
heal-all (P)	I-R	I-R	I-R	S	S
hemp-nettle (A)	R	S-I	I-R**(R)	R	
horse-nettle (P)	R				I
horsetail (P)	I-R	S-I	I-R	I-R	I
knapweeds (P)	R				I
knotweed (A)	I-R		I*(I-R)	S-I	S
Lady's-thumb (A)	S-I	I-R	I-R*(R)	I-R	S
lamb's-quarters (A)	S	S	S	S	S
lettuce, prickly (A)	S-I	S	S	S	
mallow, round-leaved (P)	I-R	I-R	I-R	I-R	
mayweed (A)	I-R		R		S
medick, black (WA)	I	I	I	S	I
milkweed (P)	R	R	R	I-R	I-R
motherwort (P)	S-I				
mullein (B)	I-R				
mustards (A)	S	S	I	S	
nightshade (P)	I-R			R	
parsnip, wild (B)	S				

Table 4-1. Classification of weeds according to response to various herbicides

Common name	2,4–D	MCPB	2,4-DB or MCPA	Mecoprop	Dicamba
pepper-grass, common (WA)	S	S-I	I		
pepper-grass, field (WA)	S	S	I		
pigweeds (A)	S	I	S-I	S	S
pineappleweed (A)	S		R	R	
plantains (P)	S	S	S-I	S-I	I
purslane (A)	I	I	S-I	S-I	
ragweed (A)	S	S	S	S	S
ragwort (B and P)	I-R	R	R	I	S-I
ribgrass (P) (see plantains)					
rocket, yellow (B)	S		I*(R)		
sheperd's purse (WA)	S-I	S	S-I	S-I	
smartweed, green (A)	S-I	I-R	I-R	I-R	S
sorrel, sheep (P)	I	R			
sow-thistle, annual (A)	S	I	S-I	I	
sow-thistle, perennial (P)	I	R	S-I*(I-R)		S-I
speedwells (A and P)	I-R	I-R		S-I	S-I
spurge, cypress (P)	I-R	I-R	I-R		I
spurge, leafy (P)	I-R	I-R	I-R	R	I
spurry, corn (A)	R	I	R	I	S
St. John's wort (P)	R	R	R	R	R
stinkweed (pennycress) (WA)	S	S	S-I	S	S
stonecrop, mossy (P)	I	I		S-I	
teasel (B)	S				
thistle, bull (B)	S	S	S	S	
thistle, Canada (P)	I	I	I	I	S-I
thistle, nodding (B)	I		I		
thistle, Russian (A)	S-I		I-R	R	S-I
toadflax (P)	R	R	R	R	
velvetleaf (A)	S-I	I	S-I*(I-R)		S-I
vetch (P)	I-R	I-R	R	I-R	I
vetches, wild (A)	S	S			
violet, field (field pansy) (A)	R			R	
water-hemlock (P)	S-I				
wood-sorrel (P)	I-R				
yarrow (P)	R	I-R		I-R	I-R

* 2,4-DB more effective (susceptibility to MCPB given in brackets)
** MCPB more effective (susceptibility to 2,4-DB given in brackets)
A–annual; WA – winter annual; B – biennial; P – perennial
S — susceptible, i.e. killed by one application of 2,4-D MCPA, or Mecoprop (1.2 kg or less per hectare) or by one application of Dicamba (425 g or less per hectare); I — intermediate, i.e. killed less rapidly but controlled, either by higher rates or by repeated applications; R — resistant, i.e. not or only slightly, damaged by chemical treatment. Control of this weed is not practical with herbicides listed; S-I — between susceptible and intermediate; I-R — between intermediate and resistant

Spray drift can damage crops a great distance from the sprayer. Grapes for wine are particularly susceptible.

For information see page 12 of this publication or the OMAF / Agriculture and Agri-Food Canada booklet *Best Management Practices — Pesticide Storage, Handling and Application* and the Ontario Pesticide Education Program (Ridgetown College) videos *How to Manage Spray Drift* and *Spray Drift Reduction Through Air Induction.*

5. Pesticide Recommendations

Table 5-1. Classification of chemicals registered for turfgrass

Trade name	Common name	LD_{50} (mg ai/kg)[1]	Chemical family
Fungicides			
Arrest	(3) carbithiin/oxycarboxin/thiram		anilide
Banner MAXX	(2) propiconazole	1310	triazole
Cadence 70 WDG	(5) boscolid	5000	anilid
Chipco Aliette T&O	(5) fosetyl-al	2860	aluminum salt
Compass 50WG	(2) trifloxystrobin	5000	strobilurin
Daconil 2787	(3) chlorothalonil	10000 +	aromatic hydrocarbon
Eagle WSP	(3) myclobutanil	2090	triazole
Heritage	(2) azoxystrobin	5000+	strobilurin
Par Ex 12-2-12 with 15% quintozene	(3) quintozene		
ProTurf DSB 20-3-19 with 1.75% thiophanate-methyl	(3) thiophanate-methyl	7000+	benzimidazole
ProTurf FF II	(3) quintozene		
ProTurf Granular Systemic Fungicide	(3) thiophanate-methyl	7000+	benzimidazole
Pro-Turf Granular Fungicide V	(3) chloroneb		
ProTurf Granular Fungicide X	(3) iprodione	3500	dicarboximide
Quintozene (many mg.)	(3) quintozene	1750-2000	aromatic hydrocarbon
Quintozene 75WP	(3) quintozene		
Rovral Green GT	(3) iprodione	3500	dicarboximide
Senator 70WP	(3) thiophanate-methyl	7000+	benzimidazole
Subdue MAXX	(2) metalaxyl	3436	phenylamide
Supra Captan	(2) captan	9000	phthalimide
Terraclor Flowable Fungicide	(3) quintozene		
Terraneb	(3) chloroneb	5000+	chlorinated hydrocarbon
Truban 30 WP	(3) etridiazole	1077	thiadiazole
Turf Pride 7-3-12 with 15% quintozene	(3) quintozene		
UAP 0-0-6 with 15% quintozene	(3) quintozene		
Insecticides			
Chipco Sevin T&O	(3) carbaryl	400-850	carbamate

Table 5-1. Classification of chemicals registered for turfgrass

Trade name	Common name	LD_{50} (mg ai/kg)[1]	Chemical family
Diazinon	(2) diazinon	108	organophosphate
Dursban, Pyrate	(3) chlorpyrifos	135	organophosphate
DZN 600EW	(2) diazinon	108	organophosphate
Merit 0.5G, Merit Solupak	(2) imidacloprid	424-475	chloronicotinyl
ProTurf Granular Insecticide I	(2) diazinon	108	organophosphate
Success 480SC	(3) spinosad		naturalyte
Turf Pride Diazinon 5G	(2) diazinon	108	organophosphate
Herbicides and growth regulators			
Acclaim Super	(3) fenoxaprop-ethyl	335	phenoxy-phenoxy
Basagran	(3) bentazon	1100	benzothiadiazine
Betasan	(3) bensulide	770	benzene sulfonamide
*Compitox, Mecoprop	(3) mecoprop	930	phenoxy
Dimension	(2) dithopyr	3600	pyridine
2,4-D (many mg.)	(2) 2,4-D 2,4-dichlorophenoxyacetic acid (2) 2,4-D/dicamba (2) 2,4-D/dichlorprop *(3) 2,4-D/mecoprop *(3) 2,4-D/mecoprop/dicamba		phenoxy phenoxy/benzoic acid phenoxy/phenoxy phenoxy/phenoxy phenoxy/phenoxy/benzoic acid
Gramoxone	(2) paraquat	157–207	bipyridylium
MCPA amines	(3) MCPA	700–1000	phenoxy
Primo MAXX	(3) trinexapac- ethyl	5050	cycloproply derivative of cyclo-hexenone
Roundup	(3) glyphosate	4320	N-(phosphonomethyl) glycine
Royal MH-60 SG	(3) maleic hydrazide		unique
Nutrite Pre-emergent Crabgrass Weed Seed Germination Inhibitor with Corn Gluten Meal - Domestic	(3) corn gluten meal		corn gluten
Nutrite Pre-emergent Crabgrass Weed Seed Germination Inhibitor with Corn Gluten Meal-Commercial	(3) corn gluten meal		corn gluten
TurfMaize Pre-emergent Weed Seed Germination Inhibitor - Domestic	(6) corn gluten meal		corn gluten
Vanquish	(2) dicamba	1040	benzoic acid
Other (goose repellent)			
Avigon	(3)Methyl-anthranilate	10,000	n/a

The numbers in brackets identify the Schedules in which the brand name products are classified: 1. restricted use permit only; 2. restricted to agriculturalists, licensed exterminators and registered custom sprayers; 3. may be available for "domestic" purposes if so registered; 4. domestic products only; 5. limited to application on agricultural land; 6. similar to Schedule 4 but registered for agricultural and commercial use. For more information on regulatory aspects of the classification, please contact your nearest Ministry of Environment office.

1. The relative toxicity may be referred to as its LD_{50}

*All products containing mecoprop are being phased out. As of 2005, these products will contain mecoprop-p isomer.

For more information on cultural control of turf pests and on integrated pest management consult OMAF Publication 162, *Diseases and Insects of Turfgrass in Ontario* and Publication 816, *Turf IPM Manual* and Chapters 3 and 4 in this publication.

Table 5-2. Insect control

Pest	Control (highest LD_{50} products listed first)	Rate /100 m^2	Use enough water for thorough coverage. Follow label instructions.
Annual bluegrass weevil, Hyperodes weevil (*Hyperodes maculicollis*)	*Dursban 2E Dursban T Pyrate 480 EC	45 mL 22.5 mL 22.5 mL	Mainly a problem on closely mowed turf composed mainly of annual bluegrass. Monitor for adults returning to turf when forsythia are in full bloom. Spray suspected problem areas in mid-April and again in mid-May or as recommended.
Ants	Chipco Sevin T&O	210-290 mL	Mow lawns and apply spray. Do not water for 2 days after treatment. Repeat in 2–3 weeks if needed.
	Dursban 2E Dursban T	45 mL 22.5 mL	Spray when pests first appear; repeat as needed.
	Pyrate 480 EC	22.5 mL	Spray when pests first appear; repeat as needed. Maximum applications are 2 per season.
	**Diazinon 500 EC Diazinon 5 G DZN 600 EW	75–150 mL 3 g/ant hill 62–125 mL	Spot treatment only.
Black turfgrass ataenius (*Ataenius spretulus*)	Merit Solupak	1(45g WSP) pk per 1200m^2	Monitor for adults in clipping baskets or with a soap flush when Van Houtte spirea and horsechestnut are in bloom. For optimum control make application prior to egg hatch of the target pest(s). Consult your local agricultural (horticultural) advisor for more specific information on timing.
	Merit 0.5 G	0.56 kg/ 100m^2	
Cutworm (various species)	Chipco Sevin T&O	210–290 mL	Monitor using a soap flush. Mow lawns and apply spray. Do not water for 2 days after treatment. Repeat in 2–3 weeks if needed.
	Dursban 2E Dursban T	45 mL 22.5 mL	Spray when pests first appear; repeat as needed.
	Pyrate 480 EC	22.5 mL	Spray when pests first appear; repeat as needed. Maximum applications are 2 per season.
European chafer (*Rhizotrogus majalis*)	Chipco Sevin T&O	210–290 mL	Apply to the early instar stage of the grub. Irrigate after application to ensure movement into root zone. Remove excessive thatch and irrigate 24 hours before treatment if soil is dry.
	Merit 0.5G Merit Solupak	0.560 kg 1(45g WSP) pack/1200m^2	Apply prior to egg hatch. Irrigation or rainfall should occur within 24 hours. On golf courses, irrigate treated areas after application. Avoid mowing turf or lawn areas until after irrigation or rainfall. Apply only once a year.
	Diazinon 500 EC Diazinon 5G Turf Pride Diazinon 5G DZN 600 EW	90 mL 900 g 900 g 75 mL	Apply when sampling shows white grub larvae actively feeding. Thoroughly irrigate after treatment. Do not use in areas where thatch is more than 3 cm thick. Control is needed if you see 5–10 grubs per 0.1 m^2 on non-irrigated turf or more than 20 grubs per 0.1 m^2 on irrigated turf.

Table 5-2. Insect control

Pest	Control (highest LD_{50} products listed first)	Rate /100 m^2	Use enough water for thorough coverage. Follow label instructions.
European chafer *continued*	Pro Turf Granular Insecticide I	720 g	Apply when sampling shows white grub larvae actively feeding. Do not use in areas where thatch is more than 3 cm thick. Make all applications to dry foliage. Thoroughly irrigate after treatment with 1.25–2.5 cm of water.
Japanese beetle (*Popillia japonica*)	Chipco Sevin T&O	210-290 mL	Apply to the early instar stage of grub. Remove excessive thatch and irrigate 24 hours before treatment if soil is dry. Irrigate after application to ensure movement into root zone.
	Merit 0.5G Merit Solupak	0.560 kg 1 (45g WSP)pack/ 1200 m^2	Apply prior to egg hatch. Irrigation or rainfall should occur within 24 hours of application. On golf courses, irrigate treated areas after application. Avoid mowing turf or lawn areas until after irrigation or rainfall. Apply only once a year.
	Diazinon 500 EC Diazinon 5G Turf Pride Diazinon 5G DZN 600 EW	90 mL 900 g 900 g 75 mL	Apply when sampling shows white grub larvae actively feeding. Thoroughly irrigate after treatment. Do not use in areas where thatch is more than 3 cm thick.
	ProTurf Granular Insecticide I	720 g	Apply when sampling shows white grub larvae actively feeding. Thoroughly irrigate after treatment with 1.25–2.5 cm of water. Do not use in areas where thatch is more than 3 cm thick. Make all applications to dry foliage.
Hairy chinch bug (*Blissus leucopterus hirtus*)			The smaller stages of chinch bug nymphs are easier to control. If damage was significant the previous year, apply when you notice damage or large numbers of chinch bugs.
	Chipco Sevin T&O	210–290 mL	Mow lawns and apply spray. Do not water for 2 days after treatment. Repeat in 2–3 weeks if needed.
	Dursban 2E Dursban Turf	45 mL 22.5 mL	Spray when pests first appear; repeat as needed.
	Pyrate 480 EC	22.5 mL	Spray when pests first appear; repeat as needed. Maximum of 2 applications per season.
	Diazinon 500 EC Diazinon 5G Turf Pride Diazinon 5G DZN 600 EW	9–18 mL 200 g 200 g 75–150 mL	For spot treatment only. Water lightly before and after application.
	ProTurf Granular Insecticide I	160 g	For spot treatment only in areas of infestation. Water lightly before and after application.
Leatherjackets (larvae of crane fly *Tipula paludosa*)			Monitor in mid-fall or early spring. Apply to late instar larvae. Consider treatment at densities at or above 20 larvae per 0.1 m^2.
	Chipco Sevin T&O golf courses only	200 mL	Apply a single treatment in 150–200 L spray volume per 100 m^2 of turf. Mow golf course turf and apply spray. Do not water for 2 days after treatment. Where treating small areas, apply in 1.5–3 L/100 m^2 of turf and irrigate after application. Remove excess thatch and irrigate 24 hours before treatment if soil is dry. Do not allow public to use treated areas during application or until sprays have dried.

Table 5-2. Insect control

Pest	Control (highest LD_{50} products listed first)	Rate /100 m^2	Use enough water for thorough coverage. Follow label instructions.
Leatherjackets *continued*	Dursban T Pyrate 480 EC	20–25 mL 20–25 mL	Apply as drenching spray in water in later fall after the flight of adult crane flies has ceased.
Sod webworm, lawn moths (*Pediasia sp.*)			Apply when you see 6 or more caterpillars per 0.1 m^2.
	Success 480 S	0.5–1.0 mL	Treat in early morning or early evening. Do not re-apply within less than 7 days. Do not water for 2 days after application. Do not mow turf for 1–3 days after treatment. Do not exceed 4 applications/year.
	Chipco Sevin T&O Diazinon 5 G Turf Pride Diazinon 5G	210–290 mL 200 g 200 g	Mow lawns and apply spray. Do not water for 2 days after treatment. Repeat in 2-3 weeks if needed.
	Diazinon 500 EC	75–150 mL	For spot treatment only in areas of infestation.
	Dursban 2E	45 mL	Delay watering or mowing the treated area for 12–24 hours after treatment.
	Dursban Turf Pyrate 480 EC	22.5 mL 22.5 mL	Delay watering or mowing the treated area for 12–24 hours after treatment.
	ProTurf Granular Insecticide I	60–120 g	For spot treatment only.
White grubs (*Phyllophaga* spp.)	ProTurf Granular Insecticide I	720 g	For suppression only. Apply when sampling shows white grub larvae actively feeding. Do not use in areas where the thatch is more than 3 cm thick. Make all applications to dry foliage. Thoroughly water product into the lawn after treatment with 1.25–2.5 cm of water.

*Do not use products containing chlorpyrifos (Dursban 2E, Dursban T, Pyrate 480 EC) in and around homes or residential areas such as parks, school grounds and playing fields. These products can be used only on golf courses, industrial sites, highway medians and sod farms.

** Products containing diazinon (Diazinon 500 EC, Diazinon 5G, Turf Pride Diazinon Granular 5G, DZN 600 EW, ProTurf Granular Insecticide I) can no longer be purchased. These products can be applied until Dec. 31, 2005.

Table 5-3. Disease control

Disease and cultural control	Chemical control	Rate /100 m^2	Interval (days)	Use enough water for thorough coverage. Follow label directions.
Algae Improve fertility and drainage. Alleviate compaction				
Anthracnose (*Colletotrichum graminicola)* Occurs June to September under humid and warm conditions. Avoid nitrogen deficiency, drought stress, soil compaction, poor drainage and excessive thatch, especially on annual bluegrass.	Daconil 2787F	170–190 mL	7–10	Recommended rates are for preventing disease establishment; use lower rate when disease conditions are light to moderate, higher rates when conditions are severe.
	*Heritage	6–12 g	14–28	Use preventively. Begin applications when conditions are favourable for disease infection, prior to disease symptom development.
	*Banner MAXX	26-51 mL	21	Apply when warm humid weather conditions occur. Do not apply more than 3 times a season.
Brown patch, Rhizoctonia blight (*Rhizoctonia solani)* Occurs under humid, warm conditions and extended periods of leaf wetness in June to September. Avoid excess nitrogen and night watering.	Daconil 2787 F	95–190 mL (fairways)	7–14	Recommended rates are for preventing establishment; use lower rate when disease conditions are light to moderate, higher rates when conditions are severe.
		95–190 mL preventive (tees and greens)	7–10	
		190–350 mL curative (tees and greens)	7–10	
	*ProTurf DSB with thiophanate-methyl	0.86 kg	14–21	Apply to moist or dry foliage.
	*Senator 70 WP	30–60 g	5–7	Apply after mowing or avoid mowing for 12 hours after application. Begin ground applications when diseases first appear. When disease pressure is severe, apply at the higher recommendations.
	ProTurf Granular Fungicide X	2.34–3.52 kg	14	To prevent disease, apply at the normal to heavy rate to moist or dry turf when disease activity is anticipated and repeat at 2-week intervals. If disease pressures are heavy, apply at the heavy rate to moist or dry foliage. When diseases are brought under control, revert back to bi-weekly normal rate applications. To control disease apply to moist or dry foliage at the heavy rate as soon as disease activity is noticed. Repeat bi-weekly until disease is under control, then revert to the normal or heavy rate applications bi-weekly.
	Compass 50 WG	4.6–6.1 g	14–21	Apply when conditions are favourable for disease development. Under low pressure, apply at 21-day intervals at the low rate and under high pressure apply at the higher rate and shorter interval.

Table 5-3. Disease control

Disease and cultural control	Chemical control	Rate /100 m^2	Interval (days)	Use enough water for thorough coverage. Follow label directions.
Brown patch *continued*	Eagle WSP	18g	14	Apply a maximum of 4 times a year.
	*Heritage	6g	14–28	Begin applications before disease is present (usually late May to June) when conditions favour disease development. During prolonged periods of favourable conditions apply using the shorter interval.
	ProTurf Granular Systemic Fungicide	0.66–1.32 kg	14–21	For prevention apply to moist or dry foliage at normal rate when disease activity is noted or suspected. May require more frequent treatments under conditions that favour the disease. To arrest the disease, apply at double the rate.
	Rovral Green GT	125–250 mL	14-21	Apply at the first signs. Under severe pressure use the higher rate and the shorter interval. Rotate with other fungicides to reduce the possibility of developing resistance.
	Terraclor FF	135-185 mL	7-10	Apply at first sign of disease. Repeat during warm, damp weather. Water area lightly with 6 mm of irrigation or rainfall.
	*Banner MAXX	51-103 mL	14	Apply preventively when conditions favour disease development. Use the higher rate under severe disease pressure. Do not apply if disease symptoms are present. Do not apply more than 6 times a season.
Cool season brown patch, yellow patch (*Rhizoctonia cerealis*) Occurs April to May and September to November.	*Banner MAXX	77–103 mL		Apply once in late fall before snow cover. Do not apply on top of snow. Do not apply more than once a season.
Dollar spot (*Sclerotinia homoeocarpa*) Occurs June to September under humid and warm conditions. Begins when iris and peony are in full bloom. Avoid nitrogen deficiency, drought stress, soil compaction and excessive thatch, especially on annual bluegrass. Light frequent application of foliar-applied nitrogen will decrease the severity.	Daconil 2787F	48–95 mL (fairways)	7–14	Preventive rates are for preventing disease establishment; use lower rate when disease conditions are light to moderate, higher rates when conditions are severe. Heritage can be tank mixed with Daconil at 190mL/100m^2. Read the Daconil and Heritage labels.
		95–190 mL (greens and tees preventive)	7–14	
		190–350 mL (greens and tees curative)	7–14	
	ProTurf Granular Systemic Fungicide	0.66–1.32 kg	14–21	For prevention, apply to moist or dry foliage at normal rate when disease activity is noted or suspected.
	*Senator 70 WP	25–30 g	10–14	Apply after mowing or avoid mowing for 12 hours after application. Begin ground applications when diseases first appear. When disease pressure is severe, apply at the higher recommendations.
	*ProTurf DSB with thiophanate-methyl	0.86 kg	14–21	Apply to moist or dry foliage. If dollar spot is not effectively controlled a thiophanate-methyl or benomyl-tolerant strain of fungi may be present.

Table 5-3. Disease control

Disease and cultural control	Chemical control	Rate /100 m^2	Interval (days)	Use enough water for thorough coverage. Follow label directions.
Dollar spot *continued*	Cadence 70 WDG	3.2–4.0 g	14	Should be applied prior to or in the early stages of disease development. Apply in 5–15 L of water/100m^2. Do not exceed 2 consecutive applications before using another mode of action for at least one application. Do not apply more than 6 times a season.
	ProTurf Granular Fungicide X	2.34-3.52 kg	14	To prevent disease, apply at the normal to heavy rate to moist or dry turf when disease activity is anticipated and repeat at 2-week intervals. If heavy disease pressures, apply at the heavy rate to moist or dry foliage. When diseases are brought under control, revert back to bi-weekly normal rate applications. To control disease, apply to moist or dry foliage at the heavy rate as soon as disease activity is noticed. Repeat bi-weekly until disease is under control, then revert to the normal or heavy rate applications bi-weekly.
	Rovral Green GT	62 mL	21	Apply at the first signs. Repeat as required. Alternate with other fungicides to reduce possibility of developing resistance.
	*Eagle 40 WSP	15–20 g	14–21	Start applications before or immediately after the first signs. Do not apply more than 4 times a year. Under conditions optimum for severe disease development the spray interval between fungicide applications should be shortest and at the highest rate.
	*Banner MAXX	26-51 mL	21-28	Apply during periods of humid, warm days and cool nights that favour heavy dew formation. Rotate with fungicides that have a different mode of action. Do not apply more than 6 times a season. Banner MAXX can be tank mixed with Heritage at 26–51 mL or with either Daconil or Primo MAXX. Read the Banner MAXX and Daconil labels.
Fairy ring	*Heritage	12	28	Apply as soon as symptoms develop. May take 2–3 weeks to disappear. Severely damaged turf may need reseeding.
Fusarium patch *(Microdochium nivale)* Avoid excess nitrogen and remove dew.	*Heritage	6 g	14–28	Apply when conditions are favourable for disease development, i.e., extended period of cool (<15.5°C) and wet weather in spring and fall.
	*Compass 50 WG	3.8 g	14	Apply in early spring and fall when conditions are favourable for disease development or when disease is present after snow melt. For curative applications apply on a 14-day interval, 2–3 times. Do not apply more than twice in a row. Do not apply more than 2.5 kg of Compass per hectare per year.
	Rovral Green GT	185 mL	21–28	Apply in spring and fall for prevention when cool and wet conditions exist.
	Par-Ex 12-2-12 (with quintozene)	1.5 kg		An application in early spring may be required if cold, wet weather persists.
	*Banner MAXX	51–103 mL	30	Apply in the fall or early spring during cool, wet weather. Use the high rate only under high disease pressure. Do not apply more than twice a season.

Table 5-3. Disease control

Disease and cultural control	Chemical control	Rate /100 m^2	Interval (days)	Use enough water for thorough coverage. Follow label directions.
Grey snow mould, Typhula blight *(Typhula spp.)* Avoid succulent turf growth in late fall. Keep turf mowed until leaf growth ceases. Use snow fencing or other methods to prevent excessive snow accumulation. Minimize thatch as this is a perfect environment for dormant sclerotia.				Control with a single application late in fall before permanent snow cover, early to late November in southern Ontario, mid-late October in northern Ontario.
	Arrest 75 W	250–375 g in a dry mixture with 2–5 kg of organic carrier such as sewage sludge		One application. Reapply if it rains after treatment or if thaws occur during winter.
	Daconil 2787 F	240-500 mL		Repeat in early spring if conditions for snow mould persist. Apply at 250–500 mL or apply 240 mL as a tank mix with 125–250 mL of Rovral Green GT.
	Eagle WSP	30g		Apply only once a year.
	*Heritage (*Typhula incarnata* control only)	18-24 g		Do not apply on top of snow. Use the higher rate if there is a history of severe snow mould infection.
	ProTurf Granular Fungicide X	1.17–2.34 kg (light to normal rate) 2.34–3.52 kg (normal to heavy rate)	14-21	To prevent disease, apply at the light or normal rate to dry foliage when disease activity is anticipated. For suppression of disease, apply to dry foliage at the normal or heavy rate prior to the first snow. Repeat in mid-winter when turf is free of snow and again immediately after the final snow melt in the spring.
	Rovral Green GT	375 g		Apply as a preventive treatment in late fall or early winter just before ground freezes or before the first snow fall.
	Terraneb SP	175–275 g		Apply as late in the fall as possible.
	ProTurf Fungicide V	1.4–2.9kg		Apply to dry or moist foliage prior to first heavy snow fall. Repeat in mid-winter if turf is free of snow. A final treatment in late winter as the snow melts extends protection. In areas where snow cover is present the entire winter apply the highest rate.
	Par-Ex 12-2-12 with quintozene	1.5 kg		Apply as late in fall as possible.
	ProTurf FF II	1.55–3.1 kg		In areas where snow cover is present the entire winter use the high rate.
	Quintozene 75WP	250 g		After treatment, water area lightly. Do not feed clippings or treated grass to livestock. Do not use on pasture grass.
	Turf Pride 7-3-12 with 15.4% quintozene	1.5 kg		Use as part of a complete fertilizer program. Where snow cover is present the entire winter, use double the recommended rate. A slight, temporary discolouration may occur following application. Do not feed clippings of treated grass to livestock. Do not use on pasture grass. Do not get product on operator or use on a windy day.
	UAP 0-0-6 with 15% quintozene	1.5–1.6 kg		

Table 5-3. Disease control

Disease and cultural control	Chemical control	Rate /100 m^2	Interval (days)	Use enough water for thorough coverage. Follow label directions.
Grey Snow Mould *continued*	Terraclor FF	370 mL		With applications made in less than 20L of water per 100m^2, the area should receive at least 6mm of irrigation or rainfall prior to snow cover. Natural precipitation is usually enough.
	*Banner MAXX	206 mL		Do not apply on top of snow or when the temperature is below 0°C. Do not apply more than once a season.
Helminthosporium Leaf spot Melting Out (*Drechslera spp.*) Avoid early spring applications of nitrogen. Raise mowing height.	Daconil 2787 F	95–190 mL (preventive greens, tees)	7–10	For prevention, spray 2 or 3 times, beginning when first spots appear in early spring.
		190–350 mL (curative greens, tees)	7–10	
		95–190 mL (fairways)	7–14	
	Compass 50WG	3.1	14-21	Apply when conditions are favourable for disease development. Use short interval under high disease pressure.
	Heritage	6-12g	14-28	Apply when conditions are favourable for disease development.
	Rovral Green GT	125 mL	14-21	Apply at the first sign of leaf spot. Repeat 2–3 times in early spring. Under severe disease pressure use the shorter spray interval. Alternate with other fungicides to reduce possibility of developing disease resistance.
	ProTurf Granular Fungicide X	1.17 kg(light rate) 2.34-3.52 kg (normal to heavy)	21-28	Apply to moist or dry turf at the preventive rate when disease activity anticipated. Repeat if needed. Apply to moist or dry foliage at the normal to heavy rate when disease activity is first noticed. Repeat as needed at intervals not closer than 2 weeks.
	*Banner MAXX	51-103 mL	14	Under light to moderate disease pressure, apply to reduce severity. Do not apply more than 3 times per season.
Low-temperature Basidiomycetes	Arrest 75 W	250 - 375 g as a spray in 15-50 L of water or in a dry mixture with 2-5 kg of organic carrier such as sewage biosolids		These diseases require snow cover for activity. Control with a single application late in fall before permanent snow cover, early to late November in southern Ontario, mid-late October in northern Ontario.

Table 5-3. Disease control

Disease and cultural control	Chemical control	Rate /100 m^2	Interval (days)	Use enough water for thorough coverage. Follow label directions.
Pink Snow Mould (*Microdochium nivale*) Avoid succulent turf growth in late fall. Keep turf mowed until leaf growth ceases. Use snow fencing or other methods to prevent excessive snow accumulation. Minimize thatch.	Arrest 75 W	250–375 g as a spray in 15–50 L of water or in a dry mixture with 2–5 kg of organic carrier such as sewage biosolids		One application. Reapply if it rains after treatment or it thaws during winter.
	Daconil 2787	250–500 g		Apply prior to snow cover and repeat in early spring if conditions for snow mould persist. Apply at 250–500 mL or apply 240 mL as a tank mix with 125-250 mL of Rovral Green GT.
	*Heritage	18–24 g		Apply once before snow cover. Do not apply on top of snow. Use the higher rate if there is a history of severe snow mould infection.
	*ProTurf DSB with thiophanate-methyl	860 g		Apply when disease activity is expected.
	*Senator 70 WP	125–175 g		Apply after mowing or avoid mowing for 12 hours after application. Begin ground applications when diseases first appear. When disease pressure is severe, apply at the higher recommendations. Repeat when needed.
	Par-Ex 12-2-12 with quintozene	1.5 kg		Apply as late in fall as possible but before permanent snowfall.
	ProTurf FF II	1.55–3.1 kg		Apply before the first heavy snow fall. Where snow cover is present the entire winter use the high rate.
	Quintozene 75WP	250 g		Following treatment, water lightly. Do not feed clippings or treated grass to livestock. Do not use on pasture grass.
	Turf Pride 7-3-12 with 15.4% quintozene	1.5 kg		Use as part of a complete fertilizer program. Where snow cover is present the entire winter, use double the recommended rate. A slight, temporary discolouration may occur following application. Do not feed clippings of treated grass to livestock. Do not use on pasture grass. Do not get product on operator or use on a windy day.
	UAP 0-0-6 with 15% quintozene	1.5–1.6 kg		
	Terraclor FF	370 mL		Apply before snowfall. With applications made in less than 20L of water per 100m^2, the area should receive at least 6mm of irrigation or rainfall prior to snow cover. Natural precipitation is usually enough.
	ProTurf Granular Fungicide X	1.17–2.34 kg (light-normal rate) 2.34–3.52 kg (normal-heavy rate)	14–21	To prevent disease, apply at the light or normal rate to dry foliage when disease activity is anticipated. For suppression, apply to dry foliage at the normal or heavy rate prior to the first snow. Repeat in mid-winter when turf is free of snow and immediately after the final snow melt.

Table 5-3. Disease control

Disease and cultural control	Chemical control	Rate /100 m^2	Interval (days)	Use enough water for thorough coverage. Follow label directions.
Pink Snow Mould *continued*	Rovral Green GT	250–375 mL		Apply prior to snow cover and repeat in early spring if conditions for snow mould persist. Use higher rates where severe disease pressure is anticipated or if disease is present at the time of application. Apply at 500 mL or apply 240 mL as a tank mix with 125–250 mL of Rovral Green GT.
	*Banner MAXX	206 mL		Apply once before snow cover. Do not apply on top of snow or when the temperature is below 0°C. Do not apply more than once a season.
Powdery mildew (*Erysiphe graminis*) Avoid excess nitrogen and shade. Increase air circulation.	*Senator 70 WP	125–250 g	14–21	Apply in a minimum of 24 L and wash into root zone with 2.5 cm of water immediately after application. Apply after mowing or avoid mowing for 12 hours after application. Begin ground applications when diseases first appear. When disease pressure is severe, apply at the higher recommendations.
Pythium blight, Cottony blight, Greasy spot *(Pythium aphanidermatum)* Avoid excess nitrogen and watering.	*Heritage	12 g	10–14	Begin application before disease is present (usually late May or June) when environmental conditions favour disease development, i.e., relative humidity greater than 90% for at least 9 hours, maximum daily temperature of 27.7°C and low temperature of 20°C.
	Terraneb SP	125 g	5–7	Apply as preventive during periods of high temperature and high humidity. Repeat if conditions remain favourable.
	ProTurf Fungicide V	1.45–2.9 kg	5–7	Apply at the recommended rate to moist foliage when high temperatures and humidity favour disease development for prevention or cure.
	Subdue MAXX	16–32 mL	10–21	Apply as a preventive. During periods of prolonged conditions favourable for disease use the lower rate for the shortest interval listed and the higher rate for the longest interval. Under severe disease conditions, use the highest rate and shortest interval specified. Do not make more than 3 applications a season.
	Aliette WDG	200 g		Apply only once when symptoms appear. Use as part of a season-long spray program with other registered pesticides.
Pythium crown and root rot (many *Pythium spp.*)	Supra Captan WDG	60 g		Do not apply more than 120 g/100m^2 per year. Apply in sufficient water for thorough coverage Apply before infection occurs.
	Terraneb SP	125 g	7–10	Apply immediately after seeding. Repeat if conditions remain favourable for disease development.
	ProTurf Fungicide V	1.49 kg	7–10	Apply at recommended rate after sowing seed at first sign of disease. Apply to moist foliage of newly seeded grass and repeat if disease persists.
	Subdue MAXX	16-32 mL	7–14	Apply immediately after seeding. Irrigate with 1–2 cm of water. Repeat if conditions are favourable. For long-term control when using seed treated with metalaxyl apply 7–10 days after seeding.
	Aliette WDG	200 g		Apply when symptoms appear. Use as part of a season-long spray program with other registered pesticides. Apply only once a season.
	Truban	190 g	7–10	Maximum of 2 applications a year. Apply when symptoms first appear. Use for golf course greens and commercial production.

Table 5-3. Disease control

Disease and cultural control	Chemical control	Rate /100 m^2	Interval (days)	Use enough water for thorough coverage. Follow label directions.
Moss Commonly associated with low fertility, poor drainage, soil compaction, heavy shade, poor air circulation and poorly adapted grasses.				
Necrotic ring spot (*Leptosphaeria korrae*) "Frog-eye" symptoms visible all year. Reduce excess thatch. Attacks Kentucky bluegrass and fine fescues. Turf-type perennial ryegrasses and some Kentucky bluegrass varieties are resistant. Provide balanced fertility. Avoid drought stress.	No chemical control available.			
Red thread (*Laetisaria fuciformis*) Avoid nitrogen deficiency, especially on perennial ryegrass and fine fescues.	*Banner MAXX	51 mL		Apply when cool, wet conditions occur. Prolonged periods of high humidity favour disease development. Do not apply more than 3 times a season.
Rust (*Puccinia spp.*) Use resistant varieties of Kentucky bluegrass and perennial ryegrass. Provide adequate levels of fertility. Mow frequently.	No chemical control.			
Slime Moulds Remove spore masses by raking or hosing off the turf.	No chemical control.			
Summer patch (*Magnaporthe poae*) Symptoms usually occur during July to August. Attacks annual bluegrass and Kentucky bluegrass. Avoid nitrogen deficiency. Apply light frequent watering during dry periods to reduce heat stress.	Eagle WSP	18g	30	Will control only low to moderate disease severity.
	*Banner MAXX	103 mL	30	Apply as a preventive. Apply first when soil temperature greater than 16°C at a 5-cm depth for 4 consecutive days, with a second application 30 days later. A third application may be required if hot, humid weather occurs. Apply with 13-21 L of water per 100m^2. Do not apply more than 3 times a season.
Take-all patch (*Gaeummannomyces graminis*) Attacks bentgrasses. Use acidifying (ammonium) fertilizers to reduce thatch pH. Avoid drought stress.	No chemical control available.			

* Systemic. Alternate or tank mix with one of the other products with different fungicide classification to minimize potential of fungicide resistance developing.

Other pests

Canada Goose

Avigon 14.5 can be used as a repellent for Canada geese. Apply 13L/ha of undiluted Avigon 14.5. Mix Avigon 14.5 with water at a ratio of 1 part product to 19 parts water. This product is registered for golf courses and municipal parks. Do not mow treated area for as long as possible after treatment. Do not apply when grass is wet or when rain is expected or when temperatures are below freezing. Repeat after 3 days if needed.

Table 5-4. Herbicide recommendations for turf

Active ingredient Trade name (formulation)	Active rate/ha Product rate/ha	Product rate/ac	
Lawns, parks, golf courses and sod farms			
Site preparation before turfgrass establishment			**Apply in 200–300 L/ha (80–120 L/ac) water.**
glyphosate* glyphosate (360)	0.27–4.32 kg 0.75–12 L	0.3–4.8 L	**Non-selective herbicide that will kill turf that is sprayed**. For actively growing weeds in the fall, or spring prior to planting. Allow 5–7 days translocation time before doing any tillage when conditions are good. If cool temperatures follow application, allow more time. Only weeds emerged at application time will be controlled. Repeat application may be necessary. For **annual weeds**, use 0.75–3.5 L product/ha (0.3–1.4 L/ac).Use 50–100 L/ha water (20–40 L/ac) for the low rate or use a surfactant with larger water volumes. Water volumes of 100–300 L/ha (40–120 L/ac) can be used with the 3.5 L/ha rate. For **dandelions and quackgrass**, use 2.5–7 L product /ha (1–2.8 L/ac). Apply when plants have at least 3–4 new leaves. Repeat treatments may be needed. The low rate (2.5 L/ha [1 L/ac]) provides a minimum of one season control. Higher rates (4.75–7L/ha [1.9–2.8 L/ac]) provide longer control. For dandelions, apply 2.5 L/ha (1 L/ac) if 15 cm or less in diameter and 3.5–5 L/ha (1.4–2 L/ac) if larger. For **perennial broadleaf weeds**, use 7–12 L product/ha (2.8–4.8 L/ac). Canada thistle and sow-thistle should be at least in early bud, milkweed at bud, bindweed at full flower, and dogbane past full bloom for best results. For undisturbed perennials such as sod in non-crop areas, use the highest rate and repeat it when plants regrow to optimum stage.
Pre-emergence grass herbicides			**Apply in 800–1000 L/ha (320–400 L/ac) water, unless otherwise stated.**
bensulide Betasan (480 g/L) Betasan (GR) (12.5 Gr)	11–14.4 kg 23–30 L 125 kg	9.2–12 L 50 kg	Apply to established turf before crabgrass emergence in early spring or in fall. Use the low rate for crabgrass and the high rate for annual bluegrass. Do not reseed the area for 1 year. Do not apply peatmoss to lawn before application. Use only on mineral soils.
chlorthal dimethyl Dacthal W-75 (75 WP)	11.625 kg 15.5 kg	6.2 kg	Apply early in spring before weed seed germination. Apply in 450–1,100 L/ha (180–440 L/ac) water. Do not apply to Cohansey and Toronto bent. Do not re-seed for 60 days.
dithiopyr Dimension (120 g/L)	0.42 kg 3.5 L	1.4 L	Apply in established turf before crabgrass emergence. Apply in 200–800 L/ha (80–160 L/ac) water. Allow turf to recover from aeration or other stresses before application. Do not apply to putting greens during the first year of establishment. Check label for sensitive varieties, including Colonial bentgrasses. Do not irrigate within 2 hours or reseed for 3 months. May be tank-mixed with Killex or other broadleaf herbicides. Do not tank-mix with other products for application to putting greens.

Table 5-4. Herbicide recommendations for turf

Active ingredient Trade name (formulation)	Active rate/ha Product rate/ha	Product rate/ac	
corn gluten meal (100%)* Nutrite Pre-Emergent, Crabgrass Weed Seed Germination Inhibitor – Commercial and Domestic	980 kg	392 kg	May inhibit dandelion and smooth crabgrass weed seed germination when used with a sound lawn maintenance program. Will not control emerged or established dandelion or smooth crabgrass. Apply to established turf twice a year for sports fields, parks, golf areas and sod farms. Use a rotary or small hand spreader. Spring application: 2 weeks before large crabgrass seed germination. Late summer or early fall: after heat stress has passed. Apply to a mature lawn where established perennial ryegrass is the predominant grass species. Do not apply on newly seeded grass: wait until after first mowing. Do not apply under windy conditions. Do not apply if overseeding or resodding that season.
corn gluten meal* (98%) Turfmaize Pre-Emergent Weed Seed Germination Inhibitor	970 kg	388 kg	May inhibit dandelion and smooth crabgrass weed seed germination when used with a sound lawn maintenance program. Will not control emerged or established dandelion or smooth crabgrass. Apply to Kentucky bluegrass turf twice a year, using a rotary or small hand spreader. Spring application: apply to established turf before smooth crabgrass and dandelion seed germination. Late summer-early fall: Apply to established turf after heat stress has passed. Apply when soil is moist and rain is forecast within 2 days. If rainfall does not occur within 2 days, irrigate. Excessive moisture at time of treatment may reduce effectiveness. Do not apply on newly seeded grass; wait until after first mowing. Do not apply if overseeding or resodding that season. Do not apply if allergic to corn.
For more information on corn gluten meal, visit the Guelph Turfgrass Institute website at:www.uoguelph.ca/GTI			
Post-emergence grass herbicides			**Apply in 400–800 L/ha (160–320 L/ac) water.**
Dithiopyr Dimension (120 g/L)	0.42–0.54 kg/ha 3.5–4.5 L/ha	1.4–1.8 L	For established turf until crabgrass reaches the 1–3 leaf stage before tillering; not recommended after 3-leaf stage. Use higher rate for larger plants or when area is heavily infested. Apply in 200–800 L/ha (80–160 L/ac) water. Allow turf to recover from aeration or other stresses before application. Do not apply to putting greens during the first year. Check label for sensitive varieties, including Colonial bentgrasses. Do not irrigate within 2 hours of application. Do not reseed for 3 months. May be tank-mixed with Killex or other broadleaf herbicides. Do not tank-mix with other products for putting greens.
fenoxaprop-p-ethyl Acclaim Super (80.5 g/L)	0.092 kg 1.14 L	0.46 L	To control crabgrass at the 1–4 leaf up to the multi-tiller stage. Good coverage is essential to control multi-tillered or grassy weeds in the reproductive phase. Make a second application on mature monostands 21 days after first application. Do not apply to bentgrass or seedling Kentucky bluegrass. Do not tank-mix with any other herbicide or pesticide. Do not apply broadleaf herbicides 7 days before or after Acclaim Super. Do not apply during periods of drought. Do not mow for 4 days before or after application. Do not irrigate for 3 hours.
Post-emergence broadleaf herbicides			**Apply in 200–400 L/ha (80–160 L/ac) water. Avoid contact with ornamentals and flowers. Avoid applying during hot, dry weather. Do not irrigate, rake, or mow for at least 24 hours. Do not apply to newly seeded lawns until after second mowing**
2,4-D * 2,4-D (470 g/L)	0.8–1.4 kg 1.7–3 L	0.68–1.2L	To control many broadleaf weeds including dandelion, lamb's-quarters, mustards, peppergrass, pigweeds, plantains, shepherd's purse, smartweeds and vetch. Damage may occur when applied to bentgrass. If used on bentgrass apply at 0.28 kg/ha. Some yellowing of bentgrass may occur.

Table 5-4. Herbicide recommendations for turf

Active ingredient Trade name (formulation)	Active rate/ha Product rate/ha	Product rate/ac	
2,4-D * 2,4-D (470 g/L) plus mecoprop** Mecoprop (150 g/L) or mecoprop/ 2,4-D** Mecoturf Plus 2,4-D ([1:1] 400 g/L) or mecoprop/ 2,4-D** Premium 2-Way Turf Herbicide ([1:1] 400 g/L) or Turf-Rite 2+2 ([1:1] 400 g/L	0.85–1.1 kg 1.81–2.34 L 0.85–1.1 kg 5.67–7.34 L 1.7–2.2 kg 4.25–5.5 L 2 kg 5 L 4.25–5.5 L	 0.72–0.93L 2.27–2.93L 1.7–2.2 L 2 L 1.7–2.2 L	May be combined with Vanquish (0.21 L/ha (0.08 L/ac)) for control of young knotweed. Damage may occur when applied to bentgrass. For newly established turf at least 4 weeks old, use 2,4-D at 1/2 the usual concentration (0.4–0.6 kg in 800 L water/ha) or mecoprop (0.4–0.6 kg in 400 L water/ha) for annual weeds.
2,4-D/ dicamba/ mecoprop** Killex (308 g/L) or Premium 3-Way Turf Herbicide (308 g/L) or Par III (308 g/L) or Tri-Kill (308 g/L) or Trillion (308 g/L	1.7 kg/ha 5.5 L/ha 5.5 L 5.5 L 5.5 L 5.5 L	 2.2 L 2.2 L 2.2 L 2.2 L 2.2 L	To control 2,4-D and MCPA-tolerant weeds such as chickweeds, clovers, ground ivy and black medick as well as many broadleaf weeds including dandelion, lamb's quarters, mustards, peppergrass, pigweeds, plantains, shepherd's purse, smartweeds and vetch. In closely mowed bentgrass (greens) apply at half doses (30 mL/100 m^2). Temporary yellowing may occur. Recovery from injury will occur 1 week after application. See precautions for Vanquish.
bentazon Basagran (480 g/L) plus oil concentrate assist	0.84 kg 1.75 L 2 L	 0.7 L 0.8 L	To control top growth of yellow nut sedge. Apply when nut sedge is young and actively growing. Make 2 applications 10 days apart. Do not mow grass 3–5 days before and after application. Do not treat until turf is well established.
Dicamba Vanquish (480 g/L)	0.6 kg 1.25 L	 0.5 L	Do not apply to bentgrass. Do not apply near shallow rooted perennials. To control broadleaf weeds including 2,4-D-tolerant weeds such as chickweeds, clover and young knotweed. Will not adequately control plantain. Vanquish alone recommended for use in certain situations; it is best when mixed at low use rates with phenoxy herbicides. Prepared mixtures of Vanquish and 2,4-D are effective on a wide range of lawn weed species, including knotweed, which is not controlled by most other herbicides except when very young. Do not use mixtures containing Vanquish close to shrubs or other susceptible ornamentals at rates above 0.425 kg/ha (active). Do not mow grass 3–5 days before and after application. Do not treat until turf is well established.
MCPA MCPA Amine (500 g/L)	1.1–1.4 kg 2.2–2.8 L	 0.88–1.12L	To control field horsetail, dandelion, lamb's quarters, mustards, plantains, shepherd's purse and wild carrot. Do not apply to bentgrass unless necessary, and then only at 0.28 kg/ha. Some yellowing may occur. Use as a substitute for 2,4-D. At slightly higher doses than 2,4-D it will usually provide as good weed control. Reduced control of dandelion and plantain may occur during dry, hot weather.
mecoprop** Compitox (150 g/L) Mecoprop (150 g/L)	0.83–1.28 kg 5.5–8.5 L 5.5–8.5 L	 2.2–3.4 L 2.2–3.4 L	To control 2,4-D and MCPA-tolerant weeds such as chickweeds, clovers, ground ivy and black medick, as well as many broadleaf weeds. May be applied to bentgrass. Apply before flower to dandelion. Repeated applications may be needed for dandelion and black medick.

* Various formulations available.

** All products containing mecoprop are being phased out. As of 2005, these products will contain mecoprop-p isomer.

Turfgrass renovation

Mow and thoroughly rake the turf to be renovated to remove all dead and cut vegetation.

Table 5-5. Herbicides recommended for turfgrass renovation

Active ingredient Trade name (formulation)	Active rate/ha	Product rate/ac	
paraquat Gramoxone (200 g/L)	2.4 kg 12 L	4.8 L	Apply in 1000 L/ha (400 L/ac) water. Will "burn off" all emerged vegetation. When old turf is dead, rotovate top 5 cm to cover dead grass, rake the surface to prepare seedbed and reseed.
glyphosate* glyphosate (360 g/L)	1.7–2.5 kg 4.75–7 L	1.9–2.8 L	Apply in 200–300 L/ha (80–120 L/ac) water after omitting at least 1 regular mowing. Ideally delay tillage for 7 days to allow for proper translocation. Direct seeding into the killed turf (no tillage) may be carried out.

* Various formulations available.

Turfgrass retardation

Treatment with maleic hydrazide (Royal MH 60 SG, 6.5–8 kg/ha (2.6–3.2 kg/ac) product) may reduce growth. Follow manufacturer's directions carefully. This chemical is recommended for use in areas where mowing and trimming are difficult and where a lawn-like appearance is not necessary.

Growth regulation

Primo MAXX reduces the frequency of mowing and the amount of grass clippings by regulating growth. Full growth regulation begins about 3–5 days after application. It can be applied to well-maintained turf on golf courses and commercial sod farms and to difficult-to-mow areas along curbs, parking lots, cart paths and bunkers and around trees, shrubs and flowers beds.

Primo MAXX may not be rainfast immediately after application, which should be completed at least three hours before irrigation or rain. Treated areas should continue to receive regular maintenance practices, including irrigation, fertilization, weed, disease and insect control when necessary.

Primo MAXX may cause temporary yellowing, which usually disappears in about one week. To minimize yellowing and enhance green colour, apply readily available nitrogen at 0.1–0.25 kg of nitrogen per 100m^2.

Primo MAXX can be applied every 4 weeks or later as required to actively growing turf at the rates shown in Table 5-6. It may be applied at one-half rate shown in Table 5-6 when applied every 2 weeks or later as needed during the summer when turf growth begins to slow or where yellowing of annual bluegrass is a concern.

A reduction in turf quality as overall appearance, including colour or density, may occur. It should recover within 2–4 weeks.

Turf treated with Primo MAXX may grow more rapidly than untreated turf for several weeks following a period of suppressed growth.

Do not make more than 7 applications a year at the rates in Table 5-6 or 14 applications at the half-rate.

Do not overlap or apply to turf that is stressed by low fertility, high temperatures, drought, frost or to turf that is diseased or insect damaged.

Do not apply Primo MAXX for 2 weeks after an aeration or verticutting.

Tank Mixtures – Pesticides

Primo MAXX can be tank-mixed with only one of the following: Heritage Fungicide, Daconil 2787, Banner MAXX fungicide or Subdue MAXX fungicide. Read all the labels and follow the precautions, directions for use (rates, diseases controlled and application intervals) and other restrictions.

Table 5-6. Recommended Primo MAXX application rates[1]

Turf type	Sod farms and golf courses, including rough areas[2, 3]	Sod farms and golf course fairways (cut at 1.0-1.9 cm)	Golf course greens
	mL/100 m^2		
Creeping bentgrass (*Agrostis stolonifera, palustris*)	-	8.0	4.0
Tall fescue (*Festuca arundinacae*)	24	-	-
Kentucky bluegrass (*Poa pratensis*)	19	8.0[4]	-
Perennial ryegrass (*Lolium perenne*)	32	16[4]	
Mixture (Creeping bentgrass, annual bluegrass) (*Poa annua*)	--	8.0[5]	4.0
Mixture – Kentucky bluegrass, tall fescue, perennial ryegrass	24	-	-
Mixture – Kentucky bluegrass, perennial ryegrass, annual bluegrass	-	16[6]	-

1 Apply only to turf species or mixtures on sites for which a rate is shown in Table 5-6. Rates shown should provide 50% suppression of turf growth under good growing conditions for a minimum of 4 weeks with minimal yellowing. Growth suppression may be less with the use of rates that are one half those shown.
2 Canopy height should be at least 3.8 cm for Kentucky bluegrass and perennial ryegrass and at least 5 cm for tall fescue.
3 Includes edging and banding applications along curbs, parking lots, cart paths, bunkers and around trees, shrubs and flower beds. Apply in a 20–30 cm band with a single nozzle sprayer.
4 About one third suppression of turf growth can be expected Primo MAXX has not been tested at the rate of 2.0 mL/100m^2. Results may be unsatisfactory.
5 Where yellowing of annual bluegrass is a concern, use half the rate and apply every 2 weeks or later as required. Where temporary discolouration of annual bluegrass can be tolerated, use the rate shown in Table 5-6 and apply every 4 weeks or later as needed.
6 Use 8.0 mL/100m^2 on fairways (and fairway-height turf on commercial sod farms) consisting of a mixture of annual bluegrass and Kentucky bluegrass.

For more information on turf herbicides, mode of action and precautions consult OMAF Publication 75, *Guide to Weed Control*.

6. Turfgrass Species and Varieties

Turfgrass species choices

Many turfgrass species are available for use in Ontario. Your choice depends on the desired appearance, intended use, level of maintenance and site conditions. A summary of turf species based on intended use is shown in *Table 6-1. Turfgrass selection*. Information on seeding rates is in *Table 6-3. Turf seeding rates*.

Table 6-1. Turfgrass selection

Use	Species
Lawns (sun)	
Moderate to high performance	Kentucky bluegrass, turf-type perennial ryegrass
Low maintenance, dry	fine fescues
Lawns (shade)	
Dry	fine fescue blend or suitable mixture with perennial ryegrasses and shade-tolerant Kentucky bluegrasses
Wet	rough bluegrass
Athletic fields	
New fields	Kentucky bluegrass blends or Kentucky bluegrass-perennial ryegrass mixture
Overseeding	turf-type perennial ryegrasses
Golf courses	
Greens	creeping bentgrass, velvet bentgrass, fine fescues (at establishment)
Tees	creeping bentgrass, velvet bentgrass, Kentucky bluegrass, turf-type perennial ryegrass
Fairways	creeping bentgrass, velvet bentgrass, Kentucky bluegrass, fine fescues

Kentucky bluegrass
(Poa pratensis)

Kentucky bluegrasses are used extensively for home lawns, sports fields, parks and sod farms. This species produces a high quality, dark green, dense turf with low growth habit of medium to fine texture. Most varieties have good cold tolerance, good recuperative potential from turf injury, good tolerance to traffic and resistance to diseases such as leaf spot.

Kentucky bluegrasses adapt to a wide range of soil and management conditions but prefer moderate fertility, well drained soil and full sun. Although not very drought resistant, Kentucky bluegrasses can survive long, dry periods in a dormant state.

Canada bluegrass
(Poa compressa)

Canada bluegrass may be used in areas that are too dry, acidic, or infertile for other lawngrasses. It does not recover well from mowing but will produce a thin, low quality turf for low-maintenance areas. It is well adapted to all cool season areas but is not recommended for a high quality lawn.

Rough bluegrass
(Poa trivialis)

Rough bluegrass is a fine-textured turfgrass best suited for areas that tend to stay moist and shady, though it is often a component of seed mixes. Seeded areas germinate rapidly, and the grass blends well with other common lawn species. It has poor high temperature and drought tolerance, and its yellowish green leaf blades turn brown under the stress of high temperature and drought.

Supina bluegrass
(Poa supina)

Poa supina was selected in Germany in the 1960s. It is currently used there on lawns, sports fields and golf courses. It is a shade tolerant and wear tolerant species that can tolerate low mowing height. It performs poorly under hot, dry conditions. It is very aggressive and is recommended for the goal mouth areas of sports fields and shaded areas on greens in the United States. It is marketed in seed mixtures with perennial ryegrass, fine fescue and Kentucky bluegrass for use on sports fields and golf courses. *Poa supina* is currently being tested in Ontario.

Weeping alkaligrass
(Puccinellia distans)

Weeping alkaligrass is a low-growing bunch-type grass with excellent tolerance of alkaline soils. It is both drought tolerant and winter hardy and looks similar to fine fescue. Weeping alkaligrass establishes rapidly but does not compete well on fertile soils. It is especially suited to areas where road salt kills the existing turf species. Weeping alkaligrass is also well suited for effluent or reclaimed water use.

Fine fescue (creeping red fescue, chewings fescue, hard fescue)
(Festuca spp.)

Fine fescues produce a fine-textured turf that is medium green in colour and of low-growth habit. These species grow well under low moisture. Most varieties perform well in moderate shade. They require very little fertilizer and are slow growing, which makes them a good choice in low-maintenance situations. If they are over fertilized they do have a tendency to become thatchy. They are also very cold tolerant.

Varieties containing endophytic fungi have exhibited increased resistance to many common turf insects, including bluegrass billbug, sod webworms and chinch bugs, therefore offering an alternative to chemical insect control. Endophyte-enhanced varieties may also exhibit increased tolerance of stress conditions. Perennial ryegrasses and tall fescue varieties may contain endophytes.

Turf-type perennial ryegrass
(Lolium perenne)

Turf-type perennial ryegrasses are being used more often for home lawns, sports fields and tees on golf courses. Perennial ryegrass is a wear-tolerant, bunch-type grass with a rapid growth rate. It does not form thatch. Improved turf-type perennial ryegrass cultivars are medium textured and medium to dark green in colour. One of the most significant improvements in turf-type perennial ryegrass cultivars is the incorporation of endophytes (beneficial fungi that live inside the turfgrass plant). Endophytes provide the grass with resistance to leaf-feeding insects such as bluegrass billbug, sod webworm and hairy chinch bugs.

Perennial ryegrass is very quick to germinate and establish. Establishment can take as little as 4 to 6 days at temperatures of 15–18°C. Because of this, perennial ryegrass is the preferred species for overseeding lawns and sports fields. It requires moderate fertility, tolerates moderate salinity and grows well in sunny to partially shady locations. It is seldom planted alone and is commonly used in seed mixtures to provide a rapid turf cover, acting as a nurse grass for the more slowly germinating Kentucky bluegrass and fine fescues.

However, ryegrass should not comprise more than 20–25% of the seed blend (based on seed weight), or its rapid germination and growth will cause excessive competition for the other species.

Perennial ryegrass can be seeded on its own to provide a high quality sports turf. Because perennial ryegrass does not have rhizomes, frequent overseeding is required to maintain a dense stand of turf.

Perennial ryegrass has the poorest low-temperature tolerance of all the perennial cool season turfgrasses. It is not winter hardy in all areas of Ontario. It does not tolerate poorly drained soils where standing water may occur in the spring and is best suited to the southern part of Ontario.

Creeping bentgrass
(Agrostis palustris)

Creeping bentgrass produces a fine-textured, high quality turf but requires intensive maintenance, including close, frequent mowing and good disease management. It is one of the most cold hardy turfgrasses. It grows best in full sun but tolerates partial shade, and it has poor drought tolerance, requiring frequent irrigation during dry weather. Creeping bentgrass has a medium establishment rate and low to medium nitrogen requirements. It is very tolerant of close mowing and can become very thatchy under high maintenance regime. Creeping bentgrass is susceptible to a wide range of diseases including dollar spot, brown patch, Pythium blight, and take-all patch.

Creeping bentgrass is most commonly used for putting and lawn bowling greens where a uniform playing surface is required. Creeping bentgrass also provides an excellent turf for golf course tees and fairways if mowed at or less than 1.2 cm. One disadvantage is its susceptibility to diseases such as dollar spot.

Colonial bentgrass
(Agrostis tenuis)

Colonial bentgrass can be used as an alternative to creeping bentgrass.

Velvet bentgrass
(Agrostis canina)

Velvet bentgrass has the finest leaf texture, highest shoot density and smoothest playing surface of all turfgrasses including creeping bentgrass and colonial bentgrass. It is light green in colour. Velvet bentgrass possesses exceptional drought, shade and disease tolerance (especially to dollar spot) while requiring very low levels of nitrogen. It also has good wear tolerance. It can be used as an alternative to creeping bentgrass, especially in shady situations or where reduced fertilizer and pesticide use is desirable. If over fertilized it has a tendency to produce excess thatch.

Tall fescue
(Festuca arundinacea)

This is a medium-to-coarse-textured turf species that is tolerant of heat, drought, shade and salt. It is suitable for a wide range of soils and requires low to moderate fertility. It is best when seeded on its own. It is currently being evaluated in Ontario for use on sports fields and along highways and boulevards.

Many tall fescue varieties contain endophytes. Consult the seed supplier for more information.

See *Table 6-2. Turfgrass species characteristics* for a summary of characteristics of each species.

Table 6-2. Turfgrass species characteristics

	Kentucky bluegrass	Perennial ryegrass	Red fescue	Chewings fescue	Hard fescue	Sheep fescue	Tall fescue	Creeping bentgrass	Velvet bentgrass
Mowing frequency	M	H	L	L	L	L	H	H	H
Establishment rate	21 days	4-6 days	13-15 days	M	S-M	S-M	QG	M	M
Nitrogen req't*	0.2-0.7	0.2-0.5	0.1-0.3	0.1-0.3	L but >sheep	0	0.2-0.5	L-M	0.15-0.25
Wear tolerance	G	E	G-P	F	G	G	G	G	G
Drought tolerance	G	VG	G	G	E	E	E	P	P
Water usage	H	M	M	L	L	best if not irrigated	H	M-H	M-H
Competitiveness	M	H	M	H	M	M	M	H	M
Thatch formation	M-H	none	L-M	M-H	M	M	none	H	VH
Shade tolerance	F-G	F-G	VG	VG	VG	VG	G	F	G
Cold tolerance	VG	P	G	G	G	G	F	E	E

* kg/100 m^2 per growing month
L-low; M-medium; H-high; G-good; E-excellent; P-poor; F-fair; V-very; Q-quite; S-slow

A list of Ontario turfgrass seed distributors can be found in *Table 6-4. Ontario distributors of turfgrass.*

Table 6-3. Turf seeding rates

Seeding species	Seeding rate /100 m^2
creeping bentgrass	0.5–1.0 kg
Kentucky bluegrass	1.0–2.0 kg
perennial ryegrass	2.0–4.0 kg
fine fescue	1.0–3.0 kg
tall fescue	2.0–3.0 kg
velvet bentgrass	0.5–0.8 kg

Table 6-4. Ontario distributors of turfgrass

Bishop Farm Seeds Ltd. Box 338, Belleville, ON K8N 5A5	(613) 968-5533 (613) 968-8617 fax
Corland Seeds Ltd. P.O. Box 336, Guelph, ON N1H 6K5	(800) 265-4321 (519) 763-5192 fax
EroGreen Seed 9446 McLaughlin Rd. N., Unit # 16, Brampton, ON, L6X 4H9	1-866-817-7333 (905) 453-1582 (fax)
Graham Turf Seeds Ltd. 1702 Elm Tree Rd, R.R. #1, Lindsay, ON K9V 4R1	(705) 878-8822 (705) 878-1978 fax
Ontario Seed Company Box 144, Waterloo, ON N2J 3Z9	(519) 886-0557 (519) 886-0605 fax
Parsons Seeds Ltd. P.O. Box 280, Beeton, ON L0G 1A0	(905) 729-2202 (905) 729-2623 fax
Pickseed Canada Ltd. 1 Greenfield Rd., Box 304, Lindsay, ON K9V 4S3	(800) 668-GROW (705) 878-9249 fax
Quality Seeds R.R. # 1 8400 Huntington Rd., Woodbridge, ON L4L 1A5	(877) 856-7333 (905) 856-7509 fax
Pro-Turf 39 Monte Vista Trail, Brampton, ON L6Z 2J7	(905) 846-3319 phone/fax (905) 839-6526
Speare Seeds Ltd. P.O. Box 171, Harriston, ON N0G 1Z0	(519) 338-3840 (519) 338-2510 fax

Time of seeding

Seeding can be done mid April to early June, mid July to end of September, or as a dormant seeding. Mid August to mid September is preferred as soil moisture and temperature conditions are optimum for germination and there is less competition from germinating weeds.

Weed control

Broadleaf weeds can be a problem in newly seeded turf. Mowing can control weeds such as mustard, ragweed and lamb's quarters. Chemical control can be applied once seedlings have been mowed several times.

Mowing newly seeded turf

For Kentucky bluegrasses, fine fescues, perennial ryegrasses and tall fescues, allow about 4 cm growth before first mowing. Maintain at mowing heights as listed in *Table 6-5. Recommended mowing heights.* For bentgrasses mow after 2.5 cm growth. For the next two to three mowings cut at 12.5 mm, gradually reducing it to the desired mowing height.

Table 6-5. Recommended mowing heights

	Mowing height	Clippings*
Greens	4.8–7.5 mm	remove
Tees	7.5–15 mm	remove
Fairways	13–23 mm	return or remove
Athletic Fields	2.5–5.0 cm	return
Lawns	4.0–6.0 cm	return

* Clippings contain nutrients the soil can use. If they are removed, additional nutrients, in particular nitrogen and potassium, should be increased. If turf is mowed regularly, clippings do not contribute to thatch accumulation.

7. Water Management

Throughout the summer, turf water requirements often exceed average rainfall.

The result is a water deficit for turf. This includes home lawns, commercial turf, sod farms, sports fields and golf course turf. To make up the water deficit, turf must be irrigated. There are many things to consider when looking at turf irrigation, including:

- laws and regulations
- irrigation scheduling and amount
- water quality
- water conservation.

Laws and Regulations

If you are using more than 50,000 L per day from a surface or groundwater source, under the Ontario Water Resources Act you need a Permit to Take Water. One acre irrigated with 13 mm of water is equal to 50,000 L. The permit ensures that all water users and water resources are protected. To apply for a permit, contact your local Ministry of the Environment office. A list is in Appendix H on page 70.

If you take water from a surface water source, you will have to provide the following information:

- the flow rate of the river, creek or stream (measured during summer)
- a location map
- GPS co-ordinates if available
- estimated daily rate of water to be used
- volume of water required for irrigation
- a completed Permit to Take Water application.

If you take water from a well, a pond replenished from a well or an excavated pond replenished by a well you may have to supply:

- a location map
- GPS co-ordinates if available
- a completed Permit to Take Water application
- water well records within the survey area
- details of pumping equipment and intake levels
- information on sub-surface conditions, e.g. pits, drill holes or other excavations
- pumping test report to show water level before and after taking the maximum amount of water that you are applying for and the time it took the water level to recover.

To build a dugout pond or by-pass pond, in addition to a Permit to Take Water, you may need construction permits from the following:

- Conservation Authority if the site is in the designated flood plain
- Ministry of Natural Resources
- Niagara Escarpment Commission.

For a Permit to Take Water application and a guide go to www.ene.gov.on.ca/envision/.

The Ontario government is proposing some changes to the Permit to Take Water. For details, go to www.ene.gov.on.ca/envision/water/spp.htm.

Irrigation scheduling for golf courses, irrigated sports fields and sod

Irrigation scheduling is influenced by many factors including soil infiltration rates and water holding capacity, rooting depth, and evapotranspiration rates.

Evapotranspiration (ET) is a measure of water the plant uses during transpiration and soil evaporation. ET is expressed in mm per day. ET is affected by temperature, light intensity, wind, humidity and the type of crop. You can estimate ETs from local weather data or on-site weather instruments. *Table 7-1. Average maximum daily evapotranspiration (ET) values (mm)* lists ETs for areas throughout the province.

Table 7-1. Average maximum daily evapotranspiration (ET) values (mm)

Month	Date	Windsor	Ridgetown	London	Simcoe	Vineland	Toronto	Mt. Forest	Trenton	Ottawa	North Bay	Thunder Bay
May	7	2.1	2.2	2.4	2.8	2.0	2.3	3.0	2.1	3.0	2.7	2.4
	14	3.5	3.7	3.7	3.7	3.6	3.6	3.6	3.5	3.7	3.1	3.1
	21	3.6	3.8	3.9	4.6	3.2	3.9	4.0	3.6	4.2	3.3	3.3
	28	4.1	4.0	3.7	4.9	3.3	3.8	3.3	3.3	3.5	2.9	3.7
June	4	4.2	4.3	4.1	4.8	3.9	4.3	4.5	4.3	4.6	3.9	4.0
	11	4.3	4.2	4.2	5.2	4.4	4.2	3.8	4.1	4.6	4.1	4.1
	18	4.2	4.3	4.1	5.4	4.3	4.4	4.5	4.0	4.6	3.9	4.1
	25	4.9	4.7	4.5	5.5	5.3	4.6	5.2	4.8	4.5	4.0	4.9
July	2	4.6	4.7	4.9	5.3	4.7	4.5	5.3	4.5	4.7	4.1	4.3
	9	5.4	5.2	4.5	5.5	5.2	4.9	5.1	5.1	5.0	4.2	4.7
	16	4.9	4.9	4.4	5.0	4.8	4.7	4.8	4.4	4.3	4.0	4.8
	23	4.7	4.6	4.4	5.6	4.4	4.8	4.5	4.5	4.9	4.0	5.1
	30	4.8	4.2	4.3	5.1	3.3	3.9	4.7	4.2	4.5	3.7	4.5
Aug	6	4.8	4.7	4.2	4.6	4.3	4.5	4.8	4.1	4.3	3.6	4.0
	13	3.6	3.8	3.5	4.5	3.3	3.6	3.2	3.3	3.2	2.6	4.2
	20	3.4	3.0	3.6	3.5	3.2	3.2	3.7	3.4	3.4	2.6	2.8
	27	3.5	3.3	3.5	4.3	3.3	3.4	3.5	3.0	3.1	2.4	2.7
Sept	3	3.5	3.2	3.4	4.5	3.2	3.3	3.3	3.2	3.5	2.7	2.8
	10	3.3	3.4	2.8	3.9	2.7	3.0	3.4	2.6	2.4	2.5	2.3
	17	2.4	2.4	2.3	3.0	2.5	2.7	2.2	1.7	1.3	1.0	1.6
	24	2.3	2.4	2.3	2.9	2.2	1.6	1.7	1.7	1.9	0.7	1.1

Measuring soil moisture

One way to schedule irrigation is by measuring soil moisture. First, estimate the maximum amount of crop-available soil water in the root zone. The available water-holding capacity is the maximum amount of water available for plant growth that a soil can hold. It varies with soil texture.

A sandy soil may have less water-holding capacity, but all of the water is available for plant growth. A clay soil has more water-holding capacity but some of it is so tightly bound to the soil that it is not available for plant growth. Each soil texture has a prescribed amount of water-holding capacity. The per cent volume of water per volume of soil for different soil textures is in *Table 7-2. Available water based on soil type.*

Table 7-2. Available water based on soil type

Soil type	Available water	300 mm rooting depth
Sandy loam	10%	30 mm
Loam	13%	39 mm
Clay	6%	18 mm

Calculate the depth of water available in the root zone by multiplying the per cent of available water times the effective rooting depth, which is 300 mm for turf.

Total crop-available soil water in the root zone at field capacity is the available water capacity of the soil texture multiplied by crop rooting depth.

Second, you must choose the limit of soil moisture depletion before irrigation should be added. For turf this is estimated at 50% crop-available soil water. You can measure this by using a tensiometer, electrical resistance blocks, time domain reflectometry or frequency domain reflectometry. All these technologies have strengths and weaknesses. Consult your irrigation supply company. For more information, see Irrigation Best Management Practices, available via the OMAF website: www.omaf.gov.on.ca.

Water budget

Another way to schedule irrigation is to develop a water budget. A water budget is based on the premise that the soil is a reservoir for available water. Available-water capacity is reached when the soil reservoir is full. Rainfall and irrigation add water to the reservoir, and crop water use and evapotranspiration take water out of the reservoir.

First, you need to determine the available-water-holding capacity of your soil. Then, measure or estimate the incoming water (rain and irrigation) and the outgoing water (evapotranspiration, run-off and drainage).

Rain and irrigation vs. evapotranspiration

The incoming water is the amount of precipitation or irrigation applied to your site. To measure this you will need a rain gauge and a knowledge of your irrigation system delivery rate in mm/hour.

The outgoing water is the water lost through evapotranspiration from plants and soil and from the runoff and drainage. *Table 7-3. Estimation of turf evapotranspiration from 1 p.m. weather observation in July and August* shows how to estimate the ET.

Table 7-3. Estimation of turf evapotranspiration from 1 p.m. weather observation in July and August

Sky	Temperature	Humidity	Wind	Turf ET (mm)
sunny	23°C or warmer	low	high	6.0
sunny	23°C or warmer	low	low	5.5
sunny	23°C or warmer	high	high	5.0
sunny	23°C or warmer	high	low	4.5
sunny	less than 23°C	low	high	4.5
sunny	less than 23°C	low	low	4.0
sunny	less than 23°C	high	high	3.8
sunny	less than 23°C	high	low	3.5
cloudy	23°C or warmer	low	high	3.5
cloudy	23°C or warmer	low	low	3.0
cloudy	23°C or warmer	high	high	2.8
cloudy	23°C or warmer	high	low	2.5
cloudy	less than 23°C	low	high	2.5
cloudy	less than 23°C	low	low	2.0
cloudy	less than 23°C	high	high	1.8
cloudy	less than 23°C	high	low	1.5

Measurements courtesy of Dr. Bob Sheard, University of Guelph (retired).

Crop factor

The values in Table 7-3 are for turf growing during July and August. A crop factor is needed to account for differences in seasonal growth. For turf, the crop factors are:

- May: 0.75
- June: 0.85
- July: 1.00
- August : 1.00
- September: 0.75
- October: 0.6

Water budget example

To avoid turf stress, irrigate when the available-water reserve is at 50% (available-water reserve is half empty). Irrigate to fill the available-water reserve. If turf is over-irrigated the result will be run-off or leaching.

For example, say the soil is a sandy loam with 30 cm of rooting zone. Table 7-2 shows that the available water reservoir is 30 mm. It is July so there is no need for a seasonal correction (crop factor). Rain a few days ago filled up the reservoir and since then it has been sunny. Now the reservoir is 70% full. Table 7-4 shows how the water budget is calculated daily. The available water each day is the amount available from the day before plus any rain or irrigation minus the ET for that day. The per cent available water is the water available in mm divided by the water-holding capacity for that soil. In our example this is 30 mm.

On day 4, the starting available water is 27.5 mm. Ten mm of rain fell and only 1.8 mm of ET was lost from the system — 27.5 + 10 – 1.8 = 35.7. The soil only holds 30 mm, so the excess water would run off or, more likely, leach below the root zone and therefore be unavailable to the plant. The difference between 35.7 and 30 is 5.7 and is reported in the run-off column.

Table 7-4. Water budget example

Day	1 p.m. temp	Weather	Rain (mm)	ET (mm)	Irrigation (mm)	Available (mm)	% available	Run-off or leach
1						21	70	
2	26	sunny, dry, light wind	0	5.5	0	(21 – 5.5) = 15.5	15.5/30 =52%	0
3	28	sunny dry, windy	0	6.0	18	15.5 +18-6 = 27.5	27.5/30 = 92%	0
4	15	cloudy, fog, windy	10	1.8	0	27.5+10-1.8 = 35.7	100%	5.7
5	18	cloudy, low humidity, high wind	0	3.5	0	30 – 3.5=26.5	26.5/30 = 88%	0
6	24	sunny, low humidity, low wind	4	7.5	0	25.5 – 7.5=18	18/30 = 60%	0
7	30	sunny, low humidity, windy	0	8.0	20	18 – 8 +20=	30/30 = 100%	0

The water budget method can significantly reduce the amount of water used on sports fields, golf course turf and sod.

Water budgeting does need to be used with care on sand-based root zones. There is a tendency to underwater at times. Also, during periods of high evapotranspiration, localized dry spots may form.

Scheduling home lawn irrigation

Most home lawns need 2.5–4.0 cm of water a week to prevent dormancy. This is best applied in the early morning to prevent long periods of leaf wetness. Most compacted topsoils on home lawns will not accept this much water in one application. The option then is to cycle the irrigation through all the stations twice. The sporadic rest period gives that area some time to allow the water to infiltrate the root zone. More information on home lawn irrigation can be found in the OMAF, *Lawn Maintenance Factsheet*, Order No. 03-059 and in "Is a brown lawn a dead lawn?" infosheet on the OMAF turf web page at www.omaf.gov.on.ca.

Quality of irrigation water

Irrigation water quality is one of the most important parts of a turf irrigation system. Irrigation water has a significant influence on the characteristics of the turf root zone. Over successive irrigation cycles, the chemicals present in the water affect the pH, soluble salts, bicarbonate level and other chemical properties of the root zone.

Problems with irrigation water quality become more important in turf management as water resources become limited and we are forced to use non-potable sources. Common symptoms of water quality problems include nutrient deficiency symptoms (e.g. improper pH), reduced growth, discolouration, wilting, leaf curling and dessication (e.g. accumulation of salts).

Solids can be present, clogging the irrigation delivery system. Biological and chemical components can affect turfgrass performance and dissolved minerals and salts can cause problems. Some salts are nutrients, but others are phytotoxic if they are present in too high a concentration. The rate at which undesirable salts accumulate depends on the amount of soluble salts in the water, the amount of irrigation applied annually, and the physical and chemical properties of the soil.

Major water quality problems include:

- water pH
- total soluble salt concentration
- sodium (Na) concentration
- relative proportion of Na
- carbonate (CO_3)
- bicarbonate (HCO_3)
- calcium (Ca)
- magnesium (Mg)
- chloride (Cl)
- boron (B).

Testing irrigation water

Test irrigation water throughout the growing season. Quality is highest in the spring, when water volumes are at their highest. There are fewer solutes in the spring, giving lower electrical conductivity (EC) values. Bicarbonate levels are also lower. For these reasons, it is a good idea to test irrigation water in the spring and compare it with subsequent tests done in the summer and early fall.

A number of chemical attributes can be tested. See *Table 7-5. Acceptable ranges for chemical properties of irrigation water for most turf species.*

Collect samples from below the surface, around the level where the intake line sits. Do this when the bottom sediment has not recently been disturbed. Collect about 500 ml (about the size of a bottle of spring water) and refrigerate it until it goes to the lab.

Where lab results show some chemical properties well out of the acceptable range, you have a few options. You can find an alternative source of irrigation water whose chemical properties fall within the acceptable ranges. You can use more water from the same source to leach excess solutes. You can also treat the water to remove salts (e.g. reverse osmosis), which is effective but costly.

Much of the soil in southern Ontario has a limestone base, giving soils and groundwater their alkalinity. Although pH is a good indicator of the acidity or alkalinity, the level of bicarbonate is a more accurate indication. The higher the level of bicarbonates, the more difficult it is to bring the pH down. You can correct water pH problems with the injection of nitric or phosphoric acid, depending on the bicarbonate content of the water.

Table 7-5. Acceptable ranges for chemical properties of irrigation water for most turf species

Chemical property	Units of measurement	Acceptable range
Salinity (TDS)	mg/L	450–2000
Salinity (EC)	dS/m	0.7–3.0
Bicarbonates (HCO_3)	mg/L	90–500
Sodium (Na)	SAR	3–9
Chloride (Cl)	mg/L	70–355
Boron (B)	mg/L	1.0–2.0

Salinity

The acceptable range for dissolved salts in irrigation water is 200–800 parts per million (ppm) or mg/L. When dissolved salts rise above 2,000 ppm, the irrigation water may injure turf. The degree of tolerance of high-salt irrigation water depends on the turf species and the root zone

mix. Cool season turfgrass species and their tolerance are listed in *Table 7-6. Relative tolerances of cool season turf species to soil salinity*. If the soil has good permeability and drainage, it can tolerate poor quality irrigation water. Periodic heavy irrigation can leach excess salts. Electrical conductivity (EC) is the measure of the total of salts and is expressed in decisiemens/metre (dS/m). It can also be expressed as millimhos per centimetre (mmhos/cm), which is equivalent to dS/m. To convert EC to ppm, dS/m=640 ppm.

Table 7-6. Relative tolerances of cool season turf species to soil salinity

Sensitive (<3 dS/m)	Moderately sensitive (3-6 dS/m)	Moderately tolerant (6-10 dS/m)	Tolerant (>10 dS/m)
Annual bluegrass	annual ryegrass	perennial ryegrass	alkali grass
Colonial bluegrass	creeping bentgrass	tall fescue	
Kentucky bluegrass	fine fescues		
Rough bluegrass			

Sodium

Sodium in turf irrigation water can decrease soil aeration, water infiltration and soil water percolation. The rate at which soils adsorb sodium from water is called the sodium adsorption ratio (SAR). SAR is expressed as:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{(Ca^{2+} + Mg^{2+})}{2}}}$$

The sodium, calcium and magnesium is expressed in mmoles/L.

SAR is used to classify the sodium hazard of water sources. A SAR above 6.0 may result in a sodium build-up in certain soils.

Bicarbonate

Reduced soil permeability can also occur when water is high in bicarbonate. High bicarbonates allow calcium and magnesium in the soil to precipitate and form calcium and magnesium carbonate. Calcium and magnesium carbonate in the presence of sodium may reduce soil permeability. The bicarbonate risk is the residual sodium carbonate (RSC) and is calculated in meq/L:

$$RSC = (CO_3^{2-} + HC_0^{3-}) - (Ca^{2+} + Mg^{2+})$$

At RSC levels above 2.5 there is a danger of the soil becoming impermeable.

Chlorides

Excessive concentrations of chlorides may cause turfgrass tip-burn and can kill shoots. Concentrations of 355 ppm are undesirable for salt-sensitive species.

Boron

Boron is an essential micronutrient needed in very small amounts. It may become toxic if irrigation water exceeds 2 ppm.

Management strategies for low quality irrigation water

During years where rainfall is abundant, irrigation with poor quality water is usually not a problem. The high quality rain water leaches any salts that may accumulate. Turf problems resulting from the use of poor quality irrigation water are usually evident during dry years.

If a soil-water test shows that soluble salts are a problem, soil cultivation and good irrigation scheduling so that there is enough water so that leaching occurs will help.

The infiltration rate, percolation rate and the drainage can affect the success of these management strategies.

Irrigation water quality issues can be complex. For a complete discussion of these issues consult "Understanding Water Quality and Guidelines to Management" by Carrow et. al., 2000.

Conserving water

You can conserve water by:

- choosing species that have improved drought tolerance, such as velvet bentgrass for fairways, greens and tees or fine fescues on home lawns
- having an efficient irrigation system design that reduces run-off, provides site-specific irrigation needs, and matches application rates to infiltration rates and uses multiple applications
- checking to see that all sprinkler heads are functioning properly, are level and are operating at the correct pressure
- doing a system test to calculate the precipitation rate and distribution uniformity and using this information to calculate an irrigation schedule
- improving irrigation scheduling by using water budget information, experience and knowledge of the site
- designing irrigation zones that include only areas of similar soil types, slopes and climatic conditions
- using a good cultivation program on sports fields, golf courses or home lawns that promotes deeper root growth and enhances water infiltration rates
- educating turf managers about water management and conservation and also educating policy makers, club officials and members, sod farmers and home owners
- catching and using run-off. Some golf courses collect drainage and run-off from parking lots and hard surfaces and store and use this water for irrigation
- using effluent water on high-sand-profile root zones or sod farms with high percolation rates
- designing a golf course that uses mulch materials, drought-resistant grasses, native grasses and ground covers, rocks and non-irrigated mounds.

References

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Duncan, R.R.; Carrow, R. N. and Huck, M. 2000. Understanding Water Quality and Guidelines to Management. USGA Green Section Record. 38 (5):14-24.

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Appendix A: Application Record

Date monitored _____ Pest found _____

Date of application _____ Time _____

Pest _____ Area treated _____

Equipment used _____ Operator _____

Weather conditions _____

Product	Preventive	Curative	Rate (ml/100 m^2)	Rate (g/100 m^2)	Amount of product used

Comments: _____

Appendix B: Turf Scouting Record

Date _____ **Scout name** _____ **Site location** _____

Green or tee _____ **Playing field** _____ **Home lawns** _____

Contact information

Name: _____

Address: _____

_____

Phone: _____

Site evaluation

		H	M	L
Age of turf: _____	Compaction	☐	☐	☐
Seed or sod: _____	Thatch layer	☐	☐	☐
Sun or shade: _____	Soil type	☐	☐	☐

Turf species

Kentucky blue	☐	Tall fescue	☐
Bentgrass	☐	Annual bluegrass	☐
Fine fescue	☐	Perennial ryegrass	☐

Comments _____

_____

_____

_____

_____

_____

_____

_____

Abbreviations

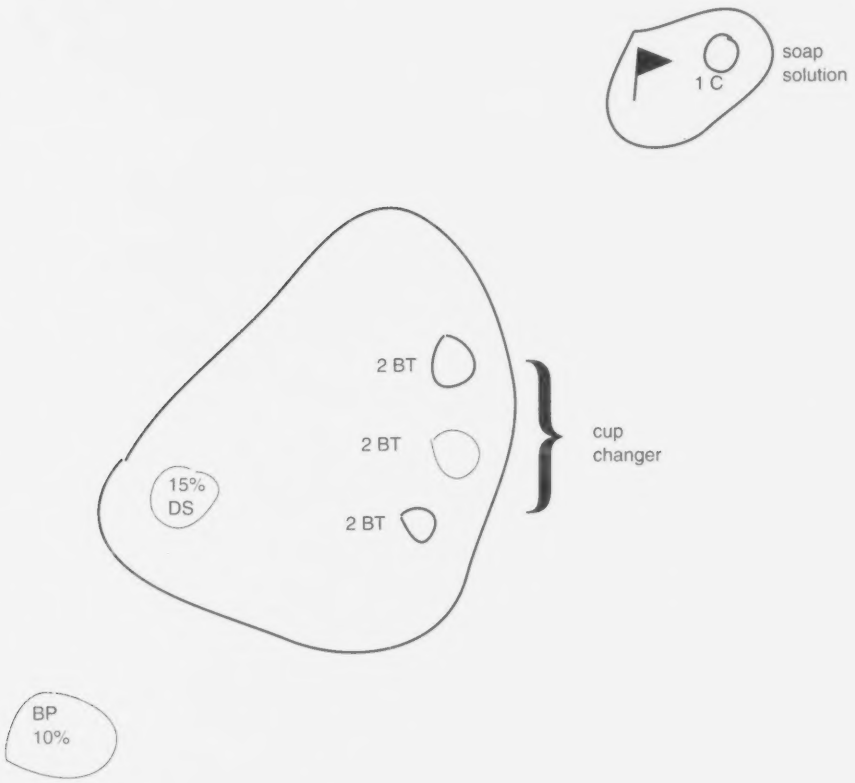
Disease	Abb.	Insect	Abb.
Anthracnose	A	Annual B. weevil	AW
Brown patch	BP	Black turfgrass ataenius	BT
Dollar spot	DS	Blue billbug	BB
Fusarium patch	F	Chinch bug	CB
Grey snow mould	GS	Cutworm	C
Leaf spot	LS	European chafer	EC
Patch disease	PD	European cranefly	ECF
Pink snow mould	PS	Japanese beetle	JB
Red thread	RT	June beetle	JuB
Rust	R	Unknown/other insect	OI
Unknown/other disease	OD		

Pest management unit map

Pest management unit map Instructions

1. Use a separate data sheet each time you scout a specific pest management unit.
2. Record the date, name of scout, site location and type of pest management unit: golf hole, sports field, home lawn.
3. Include a contact name and phone number.
4. Note the turf specie or species present.
5. Document as much information about the site as possible: age of turf, seed vs. sod, shade vs. sun, compaction, soil texture and thatch.
6. Add comments on prevailing weather that may have influenced pest development.
7. Draw a diagram of the pest management unit in the box. (See sample below.)
8. As you walk or ride in a serpentine pattern across the unit, mark the areas of disease by drawing the perimeter of the affected area. Use the abbreviations to indicate which disease or insect is present. Estimate the percentage of area affected and mark it on the map.
9. When you use specific insect monitoring teachniques, record the technique and the results on the map. For example, soap flush — 3 sw. If using the cup changer for grub detection, note the number of grubs present and species for each cup changer.

Pest management unit map



Appendix C: Golf Course Pest Scouting Form

Date _____ Relative humidity _____

Temperature: High _____ Low _____ Precipitation: Type _____ Amount _____

Cloud or sun _____ Soil temp _____ Cultural or chemical controls _____

Hole	Greens			Tees			Fairways			Roughs		
	Disease	Insect	Weed	Disease	Insect	Weed	Disease	Insect	Weed	Disease	Insect	Weed
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
PG												
PR												

PG putting green PR practice range

Legend: Diseases				Insects		Weeds	
Anthracnose foliar blight	AFB	Pink snow mould	PSM	Annual bluegrass weevil	ABW	Algae	A
Anthracnose basal rot	ABR	Pythium blight	PB	Aphodius	AP	Annual bluegrass	AB
Brown patch	BP	Pythium root rot	PRR	Black cutworm	BCW	Chickweed	C
Dollar spot	DS	Red thread	RT	Black turfgrass ataenius	BTA	Clover	Cl
Fairy ring	FR	Rusts	R	Bluegrass billbug	BB	Crabgrass	Cr
Fusarium patch	FP	Summer patch	SP	European chafer	EC	Dandelion	D
Grey snow mould	GSM	Slime moulds	S	European crane fly	ECF	Knotweed	K
Leaf spots	LS	Smuts	SM	Hairy chinch bug	HCB	Medic	M
Necrotic ring spot	NRS	Take-all patch	TAP	Japanese beetle	JB	Moss	Mo
Powdery mildew	PM	Yellow patch	YP	June beetle	JuB	Plaintain	P
		Other diseases	OD	Sod webworm	SW	Quackgrass	Q
				Turfgrass scale	TS	Spurge	Sp
				Other insects	OI	Yarrow	Y
						Other weeds	OW

Appendix D: Laboratories

These labs are accredited to perform soil tests for pH, buffer pH, P, K, Mg and Nitrate-N on Ontario soils.

Laboratory Name	Address	Telephone/Fax	Contact
A & L Canada Laboratories East, Inc.	2136 Jetstream Road London, ON N5V 3P5	tel: (519) 457-2575 fax: (519) 457-2664 aginfo@al-labs-can.com	Greg Patterson Ian McLachlin
Accutest Laboratories	146 Colonnade Road, Unit #8 Nepean, ON K2E 7Y1	tel: (613) 727-5692 fax: (613) 727-5222 phaulena@accutestlabs.com	Lorna Wilson Peter Haulena
Agri-Food Laboratories	503 Imperial Road, Unit #1 Guelph, ON N1H 6T9	tel: (519) 837-1600 1-800-265-7175 fax: (519) 837-1242 lab@agtest.com	Dale Cowan Nora Wilson
Brookside Laboratories, Inc.	301 South Main Street New Knoxville, Ohio 45871	tel: (419) 753-2448 fax: (419) 753-2949 nfisher@blinc.com	Nicole Fisher Mark Flock
Soil and Nutrient Laboratory (formerly, Analytical Services, Land Resource Science)	University of Guelph P.O. Box 3650, 95 Stone West, Guelph, ON N1H 8J7	tel: 519-767-6226 fax: (519) 767-6240 sfraser@lsd.uoguelph.ca	Stephen Fraser
Stratford Agri Analysis (A Daco Laboratories Ltd. Company)	1131 Erie St., Box 760 Stratford, ON. N5A 6W1	tel: (519) 273-4411 1-800-323-9089 fax: (519) 273-4411 saa@dacolabs.com	Dale Peters Keith Lemp

Appendix E: Diagnostic Services

Weed identification and nematode counts

Pest Diagnostic Clinic
Laboratory Services Division
University of Guelph
95 Stone Rd. West
Guelph, ON
N1H 8J7
(519) 767-6256
(519) 767-6240 fax
www.uoguelph.ca/pdc

Turf disease and insect diagnosis

Turf diagnostics
The Guelph Turfgrass Institute
328 Victoria Rd. South
Guelph, ON
N1H 6H8
(519) 824-4120 x 52055
(519) 766-1704 fax
egunn@uoguelph.ca
www.uoguelph.ca/GTI

Sample submission forms can be obtained at http://www.uoguelph.ca/GTI/td.pdf

Disease diagnosis

Choose a 10–15 cm square piece of turfgrass (a cup changer plug works well) including thatch and 5 cm of soil.

Take a sample from the outside edge of a ring or patch and include healthy and unhealthy turf as well as the interface between.

If symptoms are general, collect the sample from an area where they are of intermediate severity.

Plant identification

The entire plant (including root) is preferable. It should include lateral buds, leaves, and flowers or fruits.

Please specify where the plant came from, i.e. cultivated field, waste area, yard, etc. Also include the county of origin, if available.

Shipping plant material

Do not add moisture when packing turf samples, plants or plant parts. Wrap in newspaper, tying roots and soil off separately to reduce contamination, and put in a plastic container.

Avoid shipping over the weekend.

Insect specimens

Send dead, hard-bodied insects cushioned in a sturdy container.

Preserve soft-bodied insects such as caterpillars in alcohol.

Hnts for shipping insects

- Do not send insects in water.
- Do not tape insects to paper or send them loose in an envelope.
- Live insects should have enough food to survive until arrival. Clearly label the package with "live insects."

Sampling for nematodes

When to sample

Take soil and root samples at any time when the soil is not frozen. In Ontario nematode soil population levels are generally highest in May-June and again in September-October.

Sampling pattern

If living crop plants are present in the sample area, take samples within the row and from the area of the feeder root zone (with trees this is the dripline).

Problem areas

Take soil and root samples from the margins of the problem area where the plants are still living. If possible, also take soil and root samples from healthy areas in the same field.

Sampling soil

Take samples using a soil-sampling tube, trowel or narrow-bladed shovel. Sample soil to a depth of 20–25 cm. If the soil is bare, remove the top 2 cm before sampling. Combine 10 or more subsamples in a clean pail or plastic bag. Mix them well. Take 0.5–1 L from this to create a sample. No one sample should represent more than 2.5 ha (6.5 ac).

Number of subsamples

The number of subsamples is based on the total area samples:

- for 500 m^2 (5,400 sq ft) take 10 subsamples
- for 500 m^2 (5,400 sq ft – 0.5 ha) take 25
- for 0.5 ha–2.5 ha (1.25-6.25 ac) take 50.

Sampling roots

From small plants, take the entire root system plus adhering soil. For large plants, dig 10–20 g fresh weight from the feeder root zone and submit it.

Handling soil samples

Place in plastic bags as soon as possible after collecting.

Handling root samples

Place in plastic bags and cover with moist soil from the sample area.

Storage

Store samples at 5–10°C and do not expose them to direct sun or extreme heat or cold.

Only living nematodes can be counted. Accurate counts depend on proper handling of samples.

Appendix G: Ontario Ministry of Agriculture and Food Advisory Staff

Nursery and Landscape Advisory Services
Jennifer Llewellyn
OMAF Nursery Crop Specialist
Edmund C. Bovey Building
University of Guelph, Guelph, ON N1G 2W1
(519) 824-4120 x 52671
(519) 767-0755 fax
Jennifer.llewellyn@omaf.gov.on.ca
www.omaf.gov.on.ca

Turf Advisory Services
Pam Charbonneau
OMAF Turfgrass Specialist
328 Victoria Rd. South
Guelph, ON N1H 6H8
(519) 824-4120 x 52597
(519) 766-1704 fax
pamela.charbonneau@omaf.gov.on.ca
www.omaf.gov.on.ca

Our agriphone service
1-888-290-4441

For weekly insect and disease updates and cultural recommendations for woody landscape plants and tufgrass call the phone number above. Available April through October and accessible 24 hours a day, seven days a week. These messages are also posted on the OMAF web site at www.omaf.gov.on.ca

Other Ontario Ministry of Agriculture and Food contacts

Agricultural Information Contact Centre
(877) 424-1300 or (519) 826-4047
(519) 826-7610 fax
ag.info@OMAF.gov.on.ca
1 Stone Road West, Guelph ON N1G 4Y2

Provides province-wide, toll-free technical and business information to commercial farms, agri-businesses and rural businesses.

Guelph Government Information Centre
Staff directories: 1-888-466-2372 or (519) 826-3100

A complete list of Ontario Ministry of Agriculture and Food Crop Technology Staff is available at www. omaf.gov.on.ca

Appendix H: Ontario Ministry of the Environment Pesticides Control Offices

Central Region Toronto, Halton, Peel, York, Durham	5775 Yonge Street, 8th Floor Toronto, Ontario M2M 4J1	Tel (416) 326-6700 Toll free 1-800-810-8048 Fax (416) 325-6347
West-Central Region Haldimand-Norfolk, Niagara, Hamilton-Wentworth, Dufferin, Wellington, Waterloo, Brant	Ontario Government Building 119 King Street West, 12th Floor Hamilton, Ontario L8P 4Y7	Tel (905) 521-7640 Toll free1-800-668-4557 Fax (905) 521-7820
Eastern Region Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville, Prescott & Russell, Stormont/Dundas & Glengarry, Peterborough, Victoria, Northumberland, Renfrew, Ottawa-Carleton, Lanark, District of Nipissing (Townships of Airy, Murchison, Dickens, Lyell and Sabine)	133 Dalton Avenue Kingston, Ontario K7L 4X6	Tel (613) 549-4000 Toll free 1-800-267-0974 (in Eastern region only) Fax (613) 548-6908
Southwestern Region Elgin, Middlesex, Oxford, Essex, Kent, Lambton, Bruce, Grey, Huron, Perth, Simcoe	659 Exeter Road, 2nd Floor London, Ontario N6E 1L3	Tel (519) 873-5000 Toll free1-800-265-7672 Fax (519) 873-5020
Northern Region East Manitoulin, Nipissing, Parry Sound, Sudbury, Algoma East, Cochrane East, Haliburton, Muskoka	199 Larch Street, Suite 1101 Sudbury, Ontario P3E 5P9	Tel (705) 564-3249 Fax (705) 564-4180
Northern Region West Kenora, Rainy River, Thunder Bay, Algoma West, Cochrane West	435 James St. S., Suite 331 Thunder Bay, Ontario P7E 6S7	Tel(807) 475-1712 Toll free1-800-875-7772 Fax(807) 475-1754
Standards Development Branch	Pesticides Section 40 St. Clair Avenue West, 7th Floor Toronto, Ontario M4V 1M2	Tel (416) 327-5519 Fax (416) 327-2936
Approvals Branch	Pesticides Licensing 2 St. Clair Avenue West, 12A Floor Toronto, Ontario M4V 1L5	Tel (416) 314-8001 Toll free 1-800-461-6290 Fax (416) 314-8452

Apendix I: The Metric System

Metric Units

Linear measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1,000 metres = 1 kilometre (km)

Square measures (area)

100 m X 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic measures (volume)

Dry measure

1,000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid measure

1,000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight-volume equivalents (for water)

(1.00 kg) 1,000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g = 500 mL (0.50 L)
(0.10 kg) 100 g = 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

Weight measures

1,000 milligrams (mg) = 1 gram (g)
1,000 g = 1 kilogram (kg)
1,000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Dryliquid equivalents

1 cm^3 = 1 mL
1 m^3 = 1000 L

Application Rate Conversions

Metric to imperial (approximate)

litres per hectare x 0.09 = gallons per acre
litres per hectare x 0.36 = quarts per acre
litres per hectare x 0.71 = pints per acre
millilitres per hectare x 0.015 = fluid ounces per acre
grams per hectare x 0.015 = ounces per acre
kilograms per hectare x 0.89 = pounds per acre
tonnes per hectare x 0.45 = tons per acre

Imperial to metric (approximate)

gallons per acre x 11.23 =litres per hectare (L/ha)
quarts per acre x 2.8 =litres per hectare (L/ha)
pints per acre x 1.4 =litres per hectare (L/ha)
fluid ounces per acre x 70 =millilitres per hectare (mL/ha)
tons per acre x 2.24 =tonnes per hectare (t/ha)
pounds per acre x 1.12 =kilograms per hectare (kg/ha)
ounces per acre x 70 =grams per hectare (g/ha)

Liquid equivalents

Litres/hectare	*Approximate gallons/acre*
50	= 5
100	= 10
150	= 15
200	= 20
250	= 25
300	= 30

Dry weight equivalents

Grams or kilograms/hectare	*Ounces or pounds /acre*
100 grams	= 11/2 ounces
200 grams	= 3 ounces
300 grams	= 41/4 ounces
500 grams	= 7 ounces
700 grams	= 10 ounces
1.10 kilograms	= 1 pound
1.50 kilograms	= 11/4 pounds
2.00 kilograms	= 13/4 pounds
2.50 kilograms	= 21/4 pounds
3.25 kilograms	= 3 pounds
4.00 kilograms	= 31/2 pounds
5.00 kilograms	= 41/2 pounds
6.00 kilograms	= 51/4 pounds
7.50 kilograms	= 63/4 pounds
9.00 kilograms	= 8 pounds
11.00 kilograms	= 10 pounds
13.00 kilograms	= 111/2 pounds
15.0 kilograms	= 131/2 pounds

Metric Conversions

5 mL = 1 tsp
15 mL = 1 tbsp
28.5 mL = 1 fl. oz

Conversion Tables — Metric to Imperial

Length

1 millimetre (mm)	=	0.04 inch
1 centimetre (cm)	=	0.40 inch
1 metre (m)	=	39.40 inches
1 metre (m)	=	3.28 feet
1 metre (m)	=	1.09 yards
1 kilometre (km)	=	0.62 mile

Area

1 square centimetre (cm^2)	=	0.16 square inch
1 square metre (m^2)	=	10.77 square feet
1 square metre (m^2)	=	1.20 square yards
1 square kilometre (km^2)	=	0.39 square mile
1 hectare (ha)	=	107,636 square feet
1 hectare (ha)	=	2.5 acres

Volume (dry)

1 cubic centimetre (cm^3)	=	0.061 cubic inch
1 cubic metre (m^3)	=	1.31 cubic yards
1 cubic metre (m^3)	=	35.31 cubic feet
1,000 cubic metres (m^3)	=	0.81 acre-foot
1 hectolitre (hL)	=	2.8 bushels

Volume (liquid)

1 millilitre (mL)	=	0.035 fluid ounce
1 litre (L)	=	1.76 pints
1 litre (L)	=	0.88 quart
1 litre (L)	=	0.22 gallon (Imp.)
1 litre (L)	=	0.26 gallon (U.S.)

Weight

1 gram (g)	=	0.035 ounce
1 kilogram (kg)	=	2.21 pounds
1 tonne (t)	=	1.10 short tons
1 tonne (t)	=	2.205 pounds

Pressure

1 kilopascal (kPa)	=	0.15 pounds/in^2

Speed

1 metre per second	=	3.28 feet per second
1 metre per second	=	2.24 miles per hour
1 kilometre per hour	=	0.62 mile per hour

Temperature

°F = (°C X 9/5) + 32

Conversion Tables — Imperial to Metric

Length

1 inch	=	2.54 cm
1 foot	=	0.30 m
1 yard	=	0.91 m
1 mile	=	1.61 km

Area

1 square foot	=	0.09 m^2
1 square yard	=	0.84 m^2
1 acre	=	0.40 ha

Volume (dry)

1 cubic yard	=	0.76 m^3
1 bushel	=	36.37 L

Volume (liquid)

1 fluid ounce (Imp.)	=	28.41 mL
1 pint (Imp.)	=	0.57 L
1 gallon (Imp.)	=	4.55 L
1 gallon (U.S.)	=	3.79 L

Weight

1 ounce	=	28.35 g
1 pound	=	453.6 g
1 ton	=	0.91 tonne

Pressure

1 pound per square inch	=	6.90 kPa

Temperature

°C = (°F – 32) X 5/9

Abbreviations

% = per cent (by weight)	km/h= kilometres per hour
ai = active ingredient	kPa= kilopascal
AP = agricultural powder	L = litre
cm = centimetre	m = metre
cm2= square centimetre	m/s= metres per second
DG = dispersible granular	m^2 = square metre
DP = dispersible powder	mL = millilitre
E = emulsifiable	mm= millimetre
e.g.= for example	SC = sprayable concentrate
EC = emulsifiable concentrate	SP = soluble powder
F = flowable	t = tonne
g = gram	W = wettable (powder)
Gr = granules, granular	WDG= water dispersible granular
ha = hectare	WP= wettable powder
kg = kilogram	km/h= kilometres per hour

Emergency and First-Aid Procedures for Pesticide Poisoning

For a major spill, a theft or a fire involving a pesticide call the Ministry of the Environment at **1-800-268-6060.**

For pesticide poisonings and pesticide injuries call the **Poison Information Centre**:

Toronto	1-800-268-9017
Ottawa (Bilingual)	1-800-267-1373
Hearing Assistance (TTY)	1-877-750-2233

PREVENT ACCIDENTS

- **Read the label**. Follow all the precautions the label recommends. Read the First Aid section of the label BEFORE you begin to handle any pesticide.
- **Make sure that someone knows** what pesticides you are working with and where you are.
- **Keep a file of labels and product Material Safety Data Sheets (MSDS) for the pesticides you use**. Make sure everyone knows where to find this in case of an emergency.
- **Post emergency numbers near all telephones.**
- **Keep clean water, paper towels, extra gloves and clean coveralls close by** in case you spill pesticide on yourself.

If someone has been working with pesticides and you see any possible symptoms of pesticide poisoning or injury, take emergency action immediately.

IF AN ACCIDENT OR POISONING HAPPENS

- Protect yourself from injury first.
- Stop the exposure to the pesticide. Move the victim away from the contaminated area.
- Check the 4 basic facts — identify the pesticide, the quantity, the route of entry and time of exposure.
- Call an ambulance or the Poison Information Centre.
- Start first aid. This is **not** a substitute for professional medical help.
- **Provide the label, MSDS sheet or container to emergency personnel** at the scene — or take it with you to the hospital. Do not transport pesticide containers in the passenger compartment of the vehicle.

FIRST AID

If a pesticide comes in contact with skin:

- remove all contaminated clothing; wash skin thoroughly with lots of soap and warm water
- dry skin well and cover with clean clothing or other clean material.

If pesticide comes in contact with eyes:

- hold eyelids open wash the eyes with clean running water for 15 minutes or more.

If pesticide was inhaled:

- move the victim to fresh air and loosen tight clothing
- give artificial respiration if the victim is not breathing.

Do not breathe in the exhaled air from the victim — you could also be poisoned.

If a pesticide was swallowed:

- **call the Poison Information Centre IMMEDIATELY.**

Emergency numbers are listed at the front of each Bell telephone directory.

For information, or to obtain copies of this or any other ministry publication please:
call 1-888-466-2372 from within Ontario,

(519) 826-3700 from outside the province or OMAF's TTY line at (519) 826-7402 for the hearing impaired, email your request to *products@omaf.gov.on.ca*, or visit OMAF's web site at *www.omaf.gov.on.ca*.

A complete list of all OMAF products and services, and order forms, are available on the web site. Orders can be faxed to (519) 826-3633 or mailed to Government Information Centre,
1 Stone Road West, Guelph, Ontario N1G 4Y2.

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